JIEO REPORT - 8300

DEPARTMENT OF DEFENSE MINIMUM DESKTOP PERSONAL COMPUTER CONFIGURATION

AUG 1, 1997

Defense Information Systems Agency
Joint Interoperability and Engineering Organization
Center for Standards

FOREWORD

FOR ALL EXECUTIVES:

The Defense Information Systems Agency (DISA), Joint Interoperability and Engineering Organization (JIEO), Center for Standards (CFS), has compiled and prepared this Department of Defense (DOD) Minimum Desktop Personal Computer Configuration report, intended for use by DOD acquisition personnel involved in the procurement of desktop personal computer hardware and software.

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EXECUTIVE SUMMARY

The Defense Information Systems Agency (DISA) Center for Standards (CFS) was requested by the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (C3I) to identify a minimum configuration requirement for desktop office automation and other terminals to meet requirements such as connectivity to the Defense Information Infrastructure and Defense Message System, support for new technology such as multimedia, and Personal Computer Memory Card International Association (PCMCIA) slots for security and other requirements. These requirements were originally defined in the November 1994 version of this report. This report is an annual update of the document and includes updated requirements for the Global Command and Control System (GCCS), Global Combat Support System (GCSS) and the Defense Message System (DMS). These requirements have been fused together to derive a minimum Desktop Personal Computer configuration that is capable of supporting all of the Defense Information Infrastructure (DII) systems.

This report is consistent with the Assistant Secretary of Defense for C3I memorandum of 22 August 1996, entitled “Implementation of DOD Joint Technical Architecture (JTA),” V1.0 dtd 22 August 1996, and the DOD Personal Computer Policy Implementation Plan of 25 November 1996. This document provides guidance to assist DOD procurement officials in the acquisition of desktop personal computers to achieve interoperability with the DII systems.

1.0 INTRODUCTION

1.1 Background

This report was originally published in November of 1994, and updated in 1996. It provides initial guidance to be used by DOD for acquiring desktop personal computers that could be used to support the Defense Information Infrastructure (DII). The minimum desktop personal computer configuration was designed to meet the requirements of the major DOD-wide information systems that were being implemented at the time--the Defense Message System (DMS), the Global Command and Control System (GCCS) and the Global Combat Support System (GCSS). New requirements have since been identified and are reflected in this document.

1.2 Purpose

The purpose of this report is to identify the minimum desktop personal computer (PC) configuration for computers which will be used in DOD-wide systems and infrastructure. Many new systems being planned for implementation within DOD will use desktop personal computers (PCs) acquired under separate contracts. These new systems will run on general purpose personal computers rather than fielding system specific computers. These PCs will be used to access/support multiple systems from the same computer. While there are numerous DOD contracts for desktop computers, each of these contracts must provide computers that fit the DOD minimum configuration in order to be able to support DOD systems. For instance, DMS will not provide new desktop systems for every DMS user. Instead, DMS users will provide their own desktop personal computers for use with the DMS applications. This report identifies those minimum capabilities which must exist on a user's PC if the user needs to access the DOD-wide systems effectively to accomplish the mission.

The minimum configuration for desktop personal computers will support user requirements such as connectivity and operations within DII Common Operating Environment (COE), GCCS, GCSS and DMS while also supporting local user applications. Support for new technologies such as multimedia and the Personal Computer Memory Card International Association (PCMCIA) slots for Multilevel Information Systems Security Initiative (MISSI) security services (FORTEZZA Crypto Card) are included. The minimum PC configuration applies to systems in a network and clients in a client/server computing environment. *The minimum configuration is not designed to satisfy all of the requirements necessary for a system to operate as a server or to support system specific applications such as Computer Aided Design (CAD).*

The minimum desktop PC configuration is designed to support connectivity and operations within DII. DII is the DOD-wide system of computing and communications assets configured to satisfy the information requirements of DOD. DII is composed of communication networks and information systems to provide vital services to DOD. DII will use the Defense Information Systems Network (DISN) as its primary communications backbone. The minimum desktop PC configuration is the baseline to which other requirements can be added to satisfy specific user requirements.

1.3 Scope

The minimum desktop configuration presented in this document covers the requirements identified by the major DOD-wide systems. These systems include GCCS, DMS, and DII COE. In addition, allowances have been made for the Global Combat Support System (GCSS) an evolving part of the DII COE. This report will be reviewed annually to update existing requirements and to add new requirements as they evolve. New requirements can be generated by emerging systems and standards such as Electronic Commerce/Electronic Data Interchange (EC/EDI).

1.4 Report Organization

This report is organized into three basic sections: Applicability, Guidance, and Analysis. The Applicability section provides the basic requirements of each of the major systems (GCCS, DMS, etc.) and presents the minimum desktop personal computer configuration. The Guidance section provides information on the standards that should be followed in specifying equipment. The Analysis section provides a detailed analysis of each of the requirements that make up the minimum desktop personal computer configuration. This analysis gives the rationale for a particular requirement/specification. The Analysis section also provides specific recommendations on particular hardware issues or technology.

It is important to note that the terms "personal computer" and "PC" are used interchangeably throughout this document. The term "PC" is short for personal computer and is used in the commercial environment to refer to desktop personal computers. In contrast, the term laptop or notebook is used in the commercial environment to refer to a portable computer. The term personal computer or PC is widely understood and generally accepted to identify a desktop personal computer.

2.0 APPLICABILITY

The desktop PC configuration identified in this report provides a baseline for personal computer procurements to support DOD components and ensure interoperability with other DOD systems. Additional requirements can be added to the baseline configuration to satisfy unique functionalities. This report is applicable to all DOD organizations and DOD-wide systems. It is for the use of DOD procurement officials and Information Technology Program Managers.

2.1 DII Requirements

The minimum desktop personal computer configuration defines characteristics or features that every personal computer must have to support DII. For example, each PC must have a permanent magnetic storage device (hard disk) and temporary electronic storage (Random Access Memory). The minimum desktop personal computer configuration must also quantify these characteristics in order to provide the minimum capability to support DOD-wide systems. There are several characteristics or capabilities that must be planned for but cannot be quantified or specified until the actual implementation of a technical architecture has been determined. For example, each system must be capable of becoming a client or user on a Local Area Network. This can be implemented using several different technical solutions (Ethernet or FDDI), but a particular solution cannot be specified until implementation of the actual network architecture. In cases like this, the requirement will be listed in place of a specification.

DII is composed of several systems supported by the Defense Information Systems Network. DMS, GCCS, and GCSS are the key information systems that will comprise DII COE.

The following minimum desktop personal computer requirements were provided by the individual program offices. These requirements reflect the minimum capabilities necessary to provide the basic functionality for each system.

2.1.1 Defense Message System

The Defense Message System (DMS) provides X.400 based messaging services, global X.500 based directory services and a service managment capability, all contributing to a set of security services that provides the user with secure, accountable, and reliable writer-to-reader messaging services. The DMS will provide these services both to the organizational user, who is migrating messaging services from AUTODIN to DMS, and to the individual user that is currently using SMTP-based or other legacy e-mail services. The DMS software will replace existing messaging systems software on desktop computers and provide enhanced services. In order to support the full spectrum of DMS messaging capabilities, each desktop system is required to provide support for a minimum of one Type II Personal Computer Memory Card Interface Association (PCMCIA) card. This card interface is required for the use of Fortezza Cryptographic Card, which provides the user with authtentication, verification, and encryption services for its message traffic. A dual slot PCMCIA capability is recommended in order to allow the simultaneous use of DMS and other PCMCIA based features.

DMS is based on Commercial Off the Shelf (COTS) software. The contract has been awarded for DMS and the following criteria are based on the requirements in the DMS procurement specification. More information on DMS can be found on the DMS home page at **http://www.disa.mil/D2/DMS.html**.

The hardware requirements for supporting DMS software were based on existing equipment and kept to a minimum to ensure that no widespread replacement of desktop computers would be required. In a generic sense, minimal hardware requirements to support DMS are equivalent to those of current E-mail implementations. DMS will be based on existing X.400/X.500 software products.

The following are the minimum:

- The computer must have a microprocessor running at a minimum of 66 MHZ with the following benchmarks:

    - SPECint95 $ 3.77
    - SPEC fp95 $ 2.81

- The computer must have a minimum of 32 MB of RAM.

- The computer must provide one type PCMCIA Type II interfaces.

- The computer must provide a minimum of 1 GB of disk storage for DMS related files and software. This was expanded after the 1996 report.

- There should be at least three expansion slots available for DMS unique or shared expansion cards.

- The computer must be capable of supporting user/site specific requirements for Local Area Network (LAN) connectivity.

The above requirements were based on a one for one replacement of current COTS E-mail software with DMS compliant E-mail software. Future DMS products will be available for 32-bit operating systems. In order to provide system level security and benefit from Defense

Information Infrastructure security services, DMS products will be required to run under Windows NT. The DMS reliance on security features of the operating system and DISN Security Services will become paramount as DMS is utilized for organizational messaging and the processing of information at higher security levels. The impact will be a requirement to shift away from a 16-bit DOS/Windows environment to Windows NT in order to realize enhanced security features.

2.1.2 Global Command and Control System (GCCS)

GCCS has replaced the WorldWide Military Command and Control System (WWMCCS). GCCS also provides new functionality to support the midrange goals of *C4I for the Warrior* (C4IFTW). The key to implementing GCCS is the use of the DII COE.

GCCS is based on UNIX workstations operating on the Secret Internet Protocol Router Network (SIPRNET). It can accommodate Personal Computers accessing the system via X-terminal connections. The following configuration is required as a minimal GCCS desktop personal computer:

! Processor that meets the following benchmarks:

- SPECint95 $ 4.20
- SPECfp95 $ 3.08
  or
- CPUmark32 $ 220
  or
- iCOMP $ 800.

! Processor that has a 32-bit data path, Plug and Play (PnP) Flash BIOS, and a maximum power rating of 3.3v.

! Cache memory with the following architecture:

- L1 Cache (internal) $ 8K.

- L2 Cache $ 128K.

! 24 MB of RAM expandable to 32 MB.

! Hard Disk $ 1.0 GB.

! Expansion bus with a minimum of two PCMCIA slots and three local bus slots.

! SVGA controller and Graphics Accelerator with a minimum of 4 MB RAM. Capable of supporting a resolution of 1024x768 and a refresh rate $ 72 Hz.

! 17-inch color Monitor with a dot pitch # .28mm and a refresh rate $ 72 Hz, noninterlaced.

! Two serial (16550 UART) ports and one parallel port.

! 3.5-inch Floppy disk drive.

! 3 button mouse.

! Open systems compliant operating system with a graphical user interface.

! For LAN connectivity and system access:
- X-server software.
- LAN interface card with TCP/IP capability.

In most cases, a CD-ROM will be required for loading the operating system and applications software.

2.1.3 Global Combat Support System

GCSS was designed to integrate DOD business systems. It is designed to provide field commanders with easy "reach back" access to key administrative and logistics databases. The key for implementing GCSS is to use the DII COE. While specifics are not available for the complete GCSS environment, the following DII requirements have been adapted to provide the best approximation for GCSS requirements:

! Processor that meets the following benchmarks:

- SPECint95 $ 4.20.
- SPECfp95 $ 3.08.

! Clock Speed $ 66 MHZ.

! Systems have a minimum of the following memory cache:

- L1 Cache (internal) $ 8K.

! 24 MB of RAM expandable to 32 MB.

! Hard Disk $ 1.0GB.

! Expansion bus with a minimum of two PCMCIA slots.

! SVGA Video Controller with 1 MB RAM.

! 17-inch color Monitor.

! Two serial ports and one parallel port.

! 3.5-inch Floppy disk drive.

! 3 button mouse.

! Open systems compliant operating system with a graphical user interface.

2.2 Minimum DesktopPersonal Computer Requirements

This document provides the minimum desktop personal computer requirements for the major systems that compose the DII. Individual system requirements were developed by the program offices for these systems. These requirements are provided in Table 2-1. The first three columns provide the system configurations for a personal computer that will be used to access DMS, GCCS, or GCSS. The fourth column represents the minimum configuration for a personal computer that will be used to access all three systems. The goal is to provide a minimum personal computer configuration that can support the requirements of all three systems thereby allowing the user to access any of the systems from a single desktop personal computer. It is obvious from the chart that the GCCS requirements are driving the minimum PC configuration. GCCS is a very comprehensive system that requires significant processing power to satisfy its minimum requirements.

It is important to note that there are several components or features that are not listed in table 2.1 that may be necessary to satisfy some generic requirements of the DII systems. These components or features are addressed in section 2.4. These items are listed separately since they may not be required on every DII system but will be utilized in a majority of the systems. Some of these components are classified as multimedia components. Further information on multimedia requirements can be found in JIEO report 8303, *Multimedia Extensions to the DOD Minimum Desktop Configuration*.

Table 2-1. DOD Desktop Personal Computer Configurations

DOD DESKTOP PERSONAL COMPUTER CONFIGURATIONS				
COMPONENT	**DMS**	**GCCS**	**GCSS**	**MINIMUM CONFIGURATION**
Processor	SPECint95 $ 3.77 SPECfp95 $ 2.81	SPECint95 $ 4.20 SPECfp95 $ 3.08 or CPUmark32 $ 220 or iCOMP $ 800	SPECint95 $ 4.20 SPECfp95 $ 3.08	SPECint95 $4.20 SPECfp95 $ 3.08 or CPUmark32 $ 220 or iCOMP $ 800
Clock Speed	$ 66 MHZ	Not Applicable	$ 66 MHZ	$ 66 MHZ
Bus	$ 32-bit data path	$ 32-bit data path	$ 32-bit data path	$ 32-bit data path
CD-ROM	$ 12X speed, PnP ISO 9660 compliant	$ 12X speed, PnP ISO 9660 compliant	$ 12X speed, PnP ISO 9660 compliant	$ 12X speed, PnP ISO 9660 compliant *Recommend for future systems 24X.
BIOS	not specified	Flash, PnP	not specified	Flash, PnP
L1 Cache	$ 8K	$ 8K	$ 8K	$ 8K
L2 Cache	not specified	$ 128K	not specified	$ 128K
Power	# 5 volts	# 3.3 volts	# 5 volts	# 5 volts
RAM	32 MB	24 MB expandable to 32 MB	24 MB expandable to 32 MB	24 MB expandable to at least 32 MB. *Recommend for future systems 64MB expandable to 128MB.
Expansion Bus	1 PCMCIA slots *Recommend for future systems 2 PCMCIA slots	2 PCMCIA slots 3 Local Bus slots	2 PCMCIA slots 3 Local Bus slots	2 PCMCIA slots 3 Local Bus slots

Hard Disk	$ 1.0 GB	$ 1.0 GB	$ 1.0 GB	$ 1.0 GB, PnP Recommend > 3 GB*. (*Win 97 and MS Office 97 requires)
Video Controller	SVGA (1024x768)	SVGA Graphics Accelerator (PnP) with $ 4 MB RAM	SVGA controller with 1 MB RAM	SVGA Graphics Accelerator (PnP) with $ 4 MB RAM
Monitor	17-inch Color	17-inch Color (PnP) dot pitch # .28mm Refresh rate$ 72 Hz	17-inch Color	17-inch Color (PnP) dot pitch # .28, Refresh rate$ 72 Hz
Interfaces	2 serial, 2 parallel	2 serial, 1 parallel	2 serial, 1 parallel	2 serial, 2 parallel
Floppy Disk Drive(s)	one 3.5-inch, 1.44 MB	one 3.5-inch 1.44 MB	one 3.5-inch 1.44 MB	one 3.5-inch 1.44 MB
Pointing Device	3-button mouse	3-button mouse	3-button mouse	3-button mouse

2.3 Configuration Description

The minimum personal computer configuration is listed in the following table (2-2). The table has two components-- a requirement/specification column and a recommendations column.

Minimum Desktop Personal Computer Configuration		
Component	**Requirement/Specification**	**Recommendations**
Processor	SPECint95 $ 4.20, SPECfp95 $3.08 or CPUmark32 $ 220 or iCOMP $ 800	SPECint95 $4.25 with MMX technology.
Bus	32-bit data path	64-bit data path
BIOS	***Year 2000*** *Compliance*.	See *Year 2000* Web-site: **http://www.disa.mil/cio/y2k/cioosd.html**
BIOS	PnP Flash BIOS	none
CD-ROM	$ 12X speed, PnP ISO 9660 compliant	$16X speed ISO 9660 compliant. *Recommend for future systems 24X.

Power	# 3.3 volts	none
L1Cache (internal)	$ 8K	$ 16K
L2 Cache	$ 128K	$ 256K *write-back* *Recommend for future systems $ 512K
Random Access Memory (RAM)	$24 MB	32 MB, EDO access time # 70 ns. *Recommend for future systems 64 MB expandable to 128 MB.
Expansion Slots	$ 3 Local Bus $ 2 PC Cards	PCI local bus. *Used in Pentium and newer systems(32/64 bit applications).
Hard Disk	$ 1.0 GB, PnP, burst transfer rate $ 11 Mbps	Local Bus compatible E-IDE or SCSI-2. Recommend > 3GB* (Win 97 and MS Office requires)
Video Controller	SVGA Graphics Accelerator (PnP) with $ 4 MB RAM	Local Bus, VRAM
Monitor	.28mm pitch, PnP, Refresh rate $ 72 Hz	none
Interfaces	2 serial (16550 UART), 2 parallel port	EPP, ECP
Floppy Disk	3.5-inch, 1.44 MB	Combo 5.25 & 3.5-inch
Pointing Device	3-button mouse	optional trackball or touch pad device
Keyboard	101 Keyboard	Optional ergonomic keyboard. **NOTE**: Win 95 has 104 key keyboard

Table 2-2. Minimum Desktop Personal Computer Configuration

The requirement/specification column represents the minimum personal computer configuration requirement by major components. The recommendations column provides additional technical considerations that should be evaluated when procuring DOD computers. These recommendations are provided on a component basis and are not interdependent.

2.4 Additional Features/Components

While the minimum personal computer configuration noted above covers all of the basic requirements for a personal computer to operate in DII, there are several items or components that will be required for a majority of the systems but not necessarily all of the systems. These features or components are noted below. If the PC configuration needs these additional features or components, the following guidance will be followed.

ADDITIONAL FEATURES (COMPONENTS)		
COMPONENT	**MINIMUM CONFIGURATION**	**RECOMMENDATION**
Audio: Sound Board	Sound Blaster v3.0 compatible with true Stereo Output Plug and Play Compatible	Application Specific
Speakers	Amplified Speakers 3 to 5 Watts output	Magnetically Shielded
Microphone	unamplified	Application Specific
Fax/Modem	28.8 Kbps under V.34bis V.42bis compression/error correction Hayes AT compatible CCITT (ITU) Group 3 Fax Internal, PnP	33.6 Kbps under V.34 V.42bis compression/error correction Hayes AT compatible CCITT (ITU) Group 3 Fax Internal, PnP
Network Interface Card	TCP/IP (SNMP) supported 32 bit ISA card, PnP Network/Site specific	Local Bus card

Table 2-3. Additional Features/Components

3.0 GUIDANCE

The key to achieving interoperability and software portability is the adherence to standards. The Federal Government has established standards for computer hardware and software that apply to all branches of the government. In addition, DOD has set particular standards for computer hardware and software. These government standards are augmented or supported by commercial and international standards. Wherever applicable, the statement of a specific requirement is based on the applicable standards.

Some de facto standards have arisen from the product development of particular companies. These de facto standards (e.g., Hayes compatible modems, Sound Blaster compatible sound cards) have been accepted as indicating a specific level of performance or compatibility and should be adhered to whenever possible.

3.1 DOD Standards

All personal computer hardware and software procurements must conform to the information technology standards identified in the ***Joint Technical Architecture (JTA) and appendix F of the DOD Personal Computer Policy Implementation Plan.*** The DOD Personal Computer Policy Implementation Plan web address is **http://www.dtic.dla.mil/c3i/pcpp.html**. The web address for the JTA is **http://www-jta.itsi.disa.mil**.

The requirements identified in this report are consistent with these standards and should be adhered to during the procurement of DOD desktop personal computers. Adherence to the requirements in this document will insure interoperability with major DOD systems.

3.2 Federal Standards

The Federal Government has established several standards that apply to the procurement of computer hardware and software. One of these is the Portable Operating System Interface (POSIX). The Profile of Open Systems Internetworking Technology (POSIT) allows both Internet (TCP/IP) and OSI solutions and is an emerging standard. Where applicable, the appropriate government standards have been identified with the minimum desktop personal computer configuration. While POSIX compliance is generally associated with operating system issues, POSIX compliance can have an effect on hardware configuration and operating system support. POSIX requirements should be reviewed prior to the selection of your system configuration.

While not directly considered standards, the Federal Government has published policies mandating the use of equipment that meets specific government guidelines. The Environmental

Protection Agency's (EPA) Energy Star program falls into this category. The President has issued an Executive Order (12845) that mandates that DOD comply with the requirements of this program. This program is discussed in Appendix B.

3.3 Commercial/International Standards

COTS computer equipment is composed of different components that meet specific standards or requirements that have become accepted by the computer industry. Where applicable, these component standards have been identified. For example, CD-ROM formats have been specified in accordance with the International Standards Organization (ISO).

3.4 Joint Technical Architecture (JTA)

The DOD JTA mandates the minimum set of standards and guidelines for all DOD Command, Control, Computers, and Intelligence (C4I) systems acquisition. The purpose of the DOD JTA is:

- To provide the foundation for a seamless flow of information and Interoperability among all tactical, strategic, and sustaining base systems that produce, use, or exchange information electronically.

- To mandate standards and guidelines for system development and acquisition which will significantly reduce cost, development time, and fielding time for improved systems while minimizing the impact on program performance wherever possible.

- To influence the direction of the information industry standards-based product development by stating the DOD's direction and investment so that information industry's development can be more readily leveraged in systems within DOD.

- To communicate DOD's intent to use open systems products and implementations to industry. DOD will buy commercial products and systems, which will use open standards, to obtain the most value for limited procurement dollars.

The JTA covers areas such as Information Processing Standards, Information Transfer Standards, Information modeling and Information Standards, Human-Computer Interfaces, and Information Systems Security. The JTA, Version 1.0, dated 22 August 1996, provides DOD policy for those systems covered by DOD 5000 directives. For more information, you can access the JTA web page at **http://www-jta.itsi.disa.mil**.

3.5 Computer Security

The JTA contains specific guidance on Computer Security and requirements for C2 level security in DOD systems. While security solutions are generally handled by the operating system, there are some circumstances where hardware solutions may be the only alternative.

If an acquisition is in support of a specific DOD system, the security certification and accreditation plan for that system will specify how security will be implemented by each component of the system. The National Security Agency maintains a list of all of the security products that it has evaluated. This list can be used to find security solutions for specific implementations or requirements. The NSA Evaluated Products List (EPL) contains products that have gone through extensive testing by NSA and have received a specific rating according to the security they provide. For more information contact your Information System Security Officer (ISSO).

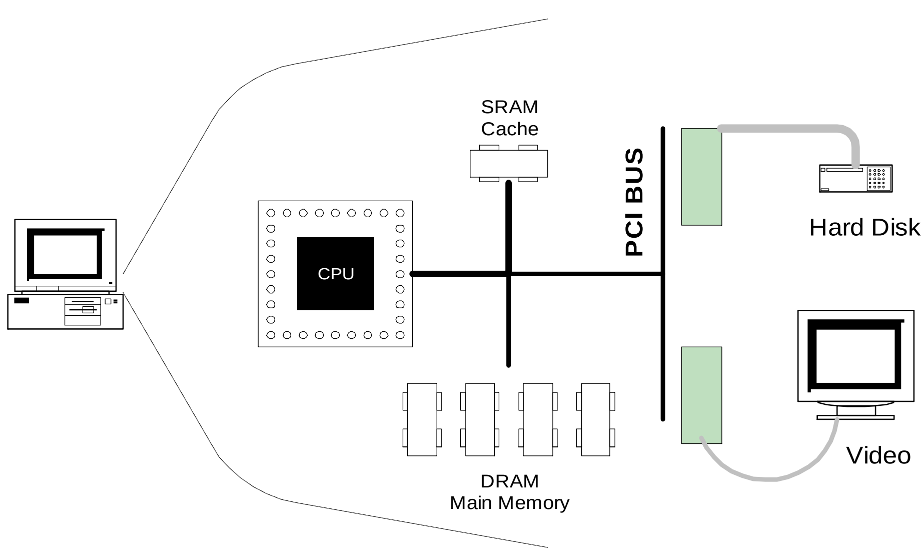
4.0 ANALYSIS

The minimum configuration guidance was developed by normalizing the requirements from each of the DII systems. This provides the minimum configuration for a desktop personal computer that will be required to access all three systems. This section provides greater detail concerning the minimum requirements and makes recommendations concerning the technologies capable of fulfilling the requirements.

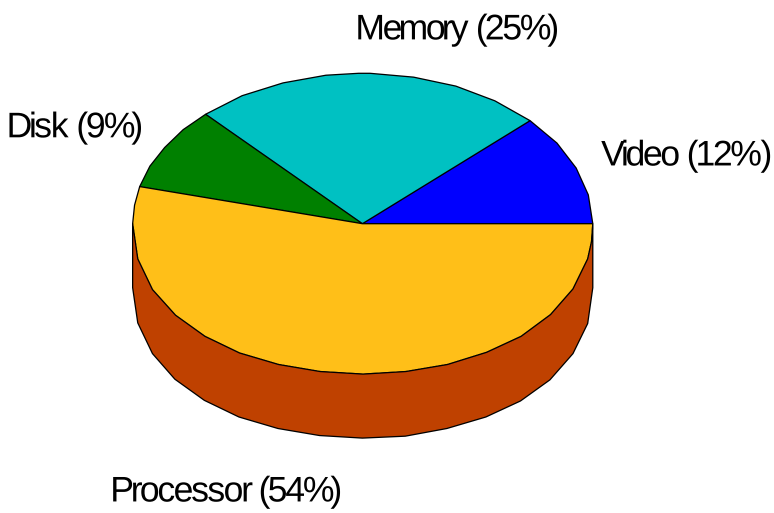
It should be noted that requirements exist which are not performance or capability oriented. One such requirement is that all DOD desktop computers be EPA Energy Star compliant (see Appendix B). Users of this document are reminded to insure that they comply with all of the DOD/government requirements.

4.1 System Configuration

A system is more than the sum of its components. A properly configured system will use the advantages of the different components to provide considerable performance improvements. The system can be tuned to provide greater performance by carefully selecting the types of system components and how they are implemented. For example, the performance of the system, when running Windows applications can be significantly enhanced by adding memory to the video card rather than increasing the performance of the processor or by adding additional main memory. Selecting the proper disk drive can improve performance significantly during Input/Output (I/O) related activities. Overall performance depends as much on the balance between system components as it does on the relative performance of any individual component.



Most modern personal computers are running some version of Windows. The overhead involved in running Windows impacts the capabilities of the system as whole. As an example, the following chart shows how much of the system is used to support a typical Windows application.



4.2 Central Processing Unit (CPU)

Component	Requirement/Specification	Recommendations
Processor	SPECint95 $ 4.20 SPECfp95 $ 3.08 or CPUmark32 $ 220 or iCOMP $ 800	SPECint95$4.25 with MMX technology. Norton SI 32 $34.2

The choice of CPU architecture is less important than insuring that it provides the required performance. Prior reports provided specific hardware specifications for the microprocessor and minimum performance specifications using the SPEC95 benchmark. Appendix A, Benchmarking, provides more insight into the benchmarking process. As noted in the recommended configuration, several benchmarks are provided in order to properly quantify the required CPU performance.

Clock speed itself does not provide an accurate picture of CPU performance. The clock speed of the CPU is only important if it is supported by high speed caching and main memory. This will be explained later in the Cache section. The selection of microprocessors running at different speeds has increased significantly over the last two years due to clock doubling and tripling technologies. This is true in the 486 families of chips and in the Pentium© class chips. The 486 processor family has more than eight different speed processors ranging from 16 MHZ to 100 MHZ. The Intel Pentium© processor family is currently composed of twelve different speed processors ranging from 60 MHZ to 266 MHZ. If you compare these two processor architectures, you will note that there is an overlap in clock speed between the two families. This is the core of the problem when you consider clock speed as a performance criteria. If you use clock speed alone, it would be logical to assume that a 486DX4 running at 100 MHZ would provide better performance than a Pentium P5© running at 60 MHZ. Using any of the current CPU benchmarks, you will find that the Pentium© has a higher performance rating than the 486DX4. This is the reason that clock speed is being eliminated as a processor requirement.

Instead of providing a single performance benchmark for the CPU requirement, three benchmarks are used. These represent a cross section of benchmarks that are available for comparing the performance of microprocessors. For a CPU to meet the minimum requirements, it must meet or exceed one of the benchmarks. There is no intent to promote a specific benchmark but to use the benchmarks to establish a minimum performance requirement. While these benchmarks can provide a good indication of the performance of the CPU, system performance is greatly affected by the selection of several key components such as the hard disk drive, video accelerator, and Random Access Memory. There are benchmarks that can be used to test the total system configuration and generate relative performance values. These are useful for evaluating different system configurations. As noted, these benchmarks are explained in Appendix A.

Performance Requirement:

SPEC95: SPECint95 $ 4.20 and SPECfp95 $ 3.08

The SPEC95 is an update to the previous SPEC92 requirements. The stated SPECmarks insure that the minimum CPU performance will be equivalent to Pentium© class performance, which will meet the minimum requirement for GCCS desktop personal computers. These benchmarks together comprise the SPEC95 evaluation.

CPUmark32: CPUmark32 $ 220

The CPUmark32 benchmark is the CPU portion of the Ziff-Davis set of benchmarks called WinBench 96. The CPUmark32 provides a processor benchmark for measuring the performance potential for running 32-bit applications. The CPUmark value of 220 will ensure that the processor meets the minimum requirements for a GCCS desktop personal computer.

iCOMP Index: $ 800

This index compares processors using a weighted average of several benchmarks. An index of 800 basically will insure that the CPU will provide (at minimum) Pentium® class performance, which is the minimum requirement for GCCS desktop personal computers.

Recommendation:

The following benchmarks can be used to augment the benchmarks above to insure that individual system requirements (e.g., windows, 32-bit applications) are met. The values shown insure compliance with the minimum requirements above.

Norton SI 32: $ 34.2

The Norton SI 32 benchmark is a new 32-bit Windows 95 benchmark designed to show the speed of a computer subsystem (CPU, L2 cache, and memory.) This benchmark is useful in comparing systems with different sized caches and memory.

Associated CPU Components/Features

Component	Requirement/Specification	Recommendations
Bus	$32-bit data path	64-bit data path
BIOS	PnP Flash BIOS	None
Power	# 3.3 volts	None

The CPU bus or data path is the communications path for the components of the CPU. The bus is usually divided into three buses--the data bus, the address bus, and the control bus. The data bus is responsible for transferring data between the CPU and main memory. The larger the data bus the more information that can be transferred per CPU cycle. The standard data bus is 32-bits. Newer systems with higher performance microprocessors are using 64-bit data buses in order to keep pace with the higher speed processors.

The BIOS or Basic Input/Output System, is the software that operates at the lowest level to control the operations of a system. Initially, BIOS was loaded in Read Only Memory (ROM) so that the system could always be booted because the BIOS was incorruptible. Unfortunately, any corrections or improvements to the BIOS would then require that the ROM be swapped out. This has changed significantly with the introduction of flash memory and flash BIOS. Flash memory is nonvolatile memory in that it does not lose its data with the removal of electric current. It is essentially an Erasable Programmable ROM that can be erased and reprogrammed using low voltage circuits. It is called flash memory because it can be erased and reprogrammed (without being removed from the computer) in a couple of seconds. One of the first uses for such memory was to store the system BIOS. This is often referred to as flash BIOS because the entire BIOS can be replaced in a matter of seconds. As new devices and capabilities are introduced, the system BIOS can be reprogrammed to support new requirements. In addition, the BIOS should be Plug and Play compatible. This requires that the BIOS interact with expansion boards/devices to coordinate the system configuration. For more information on Plug and Play see section 4.14.

Desktop personal computers have benefitted from technology improvements that have come about due to mobile/notebook computing. One of the most dramatic increases has been the area of CPU power consumption, often referred to as Voltage Reduction Technology. Higher voltages generally translate into high temperatures for electronic components. This has been particularly true in the faster microprocessors. The high end 486 processors have been responsible for introducing heat sinks, heat pipes, and PC fans. The problem is that components that run too hot will be more likely to fail during normal usage and may shorten the lifespan of different system components. It is a known fact that the closer together electronic components are placed, the more heat dissipation becomes a problem. Placing electronic components closer together reduces the amount of air available to dissipate heat. While fans can make up for the reduction in air volume by replacing the hot air with cooler air, this approach has limitations. In the small spaces provided in notebook computers, heat is a major issue. Since fans and large heat sinks are not compatible with design limits for mobile computing, the goals were to provide greater processing power at lower voltages thus generating less heat. Voltage technology was introduced into microprocessor technology so that the CPU could run at lower voltages and still communicate with external devices operating at higher voltages. The newer high speed processors run at 2.9v internally and communicate with external devices at 3.3 volts.

Requirement: 32-bit data bus, PnP Flash BIOS, Voltage Reduction to a maximum of 3.3v.

Recommended: 64-bit data bus for higher speed processors.

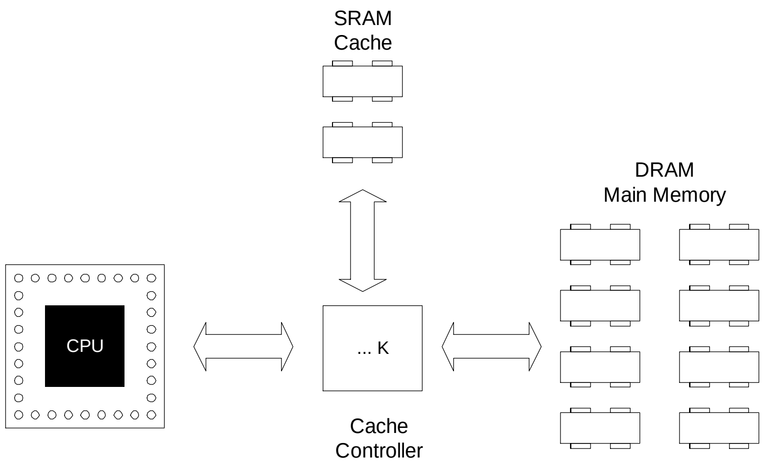
4.3 Cache

Component	Requirement/Specification	Recommendations
L1 Cache (Internal)	$ 8K	$16K
L2 Cache	$ 128K	$ 256K *write-back* *Recommend for future systems $ 512K

The requirement for cache is based on the fact that the microprocessor runs at a significantly higher speed than the memory that supports it. This causes a bottleneck where the microprocessor is generally waiting for data from memory. The most prevalent type of memory on the market today is Dynamic Random Access Memory (DRAM), which runs at a significantly slower rate than the slowest of the current microprocessors. Its main advantage is that it is cheaper to manufacture. Faster Static Random Access Memory (SRAM) can be used, but it costs significantly more than DRAM. This cost is due to the higher complexity of the SRAM chip. As the name implies, the SRAM chip stores its information in a steady state. DRAM chips store information as charges in a capacitor and require the charges to be refreshed on a periodic basis to keep the information. Since the SRAM chip does not require a refresh cycle, it provides faster access times. A SRAM chip generally provides access times in the 15-25 ns range while DRAM chips provide access times in the 60-70 ns range.

The cache architecture attempts to capitalize on the speed of the SRAM and the cheapness of DRAM. This is done by inserting a block of SRAM (and a controller) between the CPU and main memory. The SRAM and controller can be built into the chip (internal or L1 cache) or as a separate device (L2 cache). The purpose is the same, to match the speed of the processor and the memory to insure that the processor is never idle--waiting for data.

This process is not as simple as it sounds because the cache must predict what information the processor will require in the next cycle. The process for doing this is very complex and is not perfect. Sometimes, the cache will not have the information requested by the processor and the data will have to be retrieved from main memory. Of course, the larger the cache, the more data that can be stored and the greater the likelihood of the required data being in the cache.



There is a limit to the amount of cache that can be built onto the chip itself. This limit is a tradeoff between physical size and cost. Generally, 8K is the normal size for internal or L1 cache, but some chips have up to 32K in L1 cache. While this seems small, the effect on overall performance is significant. External or L2 cache generally runs from 128-512K bytes. Originally the external or Level-2 cache was located external to the processor chip to simplify design and production. This was also done so L2 cache could be offered as an option to increase system performance but left off if price was an issue. L2 cache has such a significant role in system performance that it is now being incorporated into the microprocessor chip. Therefore, it is no longer referred to as an external cache. The normal design of modern systems allows for both L1 and L2 caches. The CPU will access the L1 cache first. If the data required by the CPU is not available in the L1 cache, the CPU then accesses the L2 cache for the information. Caching schemes generally insure that the required data will be in the L1 or L2 cache. Rarely will the CPU have to access the slower main memory to get the data. It is important to note that caching schemes are designed so that the cache predicts the next data required by the CPU and brings that data into the cache before the CPU requests it. This keeps the CPU working while the cache performs the slower main memory operations.

Older DRAMs are slowly being replaced by faster Extended Data Out (EDO) DRAMs. EDO DRAMs have shown about a 10% increase in average performance over the older DRAMs at the same price. Memory technology is being pressed to keep pace with the higher speed processors like the Pentium® and K5®. While EDO DRAM is providing a speedier path between the processor and the main memory, the increase is not significant enough to eliminate the need for cache memory.

Even as EDO DRAM is being fielded, manufacturers are looking for newer memory technologies. Work on improving the EDO DRAM (*burst* EDO) has been curtailed because manufacturers are focusing on synchronous DRAMs (SDRAM). Leading edge technology as of Summer 1997 supports 266 MHZ speeds in main memory applications. As the name implies, SDRAMs are synchronized to the speed of the bus so that the access speed is nearly doubled and the throughput is significantly increased. SDRAMs are available in systems today.

The last item that must be addressed on the subject of cache is the question of what strategy is used by the cache controller to store data. There are two major strategies, *write-through* and *write-back*. *Write-through* is the simplest and means that all write operations by the processor are sent straight to main memory and no data is cached. *Write-back* means that all write operations are sent to the cache, and only the cache is updated--main memory is not updated. The main memory is only updated when an explicit instruction is sent out by the processor. This strategy improves performance because the slow process of writing to main memory is only performed when required.

Requirement: That the processor have at least 8K of L1 (internal) cache and at least 128K of L2 cache.

Recommendation: That 16K of L1 cache be used and at least 256K of L2 cache. That the cache be implemented using a *write-back* strategy.

4.4 Random Access Memory (RAM)

Component	Requirement/Specification	Recommendations
Random Access Memory	$ 32 MB	32 MB * Recommend for future use 64 MB RAM.

GCCS systems and DII COE systems will be supporting the newer operating systems (Windows NT and Windows 95). While Microsoft states that the newer operating systems can be used with as little as 4-8 MB, these are not very efficient configurations. Experience has shown that 24 MB is the true minimum requirement for adequate performance with the newer 32-bit operating systems.

Using windows is a very memory intensive operation. As noted earlier, to improve performance, modern PCs store data in RAM in order to limit the time the processor has to wait for information. If a PC does not have sufficient RAM, then the processor has to spend more time requesting information from the slower hard disk. The amount of RAM and its speed plays a major role in total system performance.

The newer DRAM modules have significantly faster access times than previous DRAMs (60-70 nanoseconds). The faster the access time, the less time the processor has to wait for information, thus the greater the performance. Unfortunately, the new, speedier DRAMS are placed in Single In-line Memory Modules (SIMMs) that are different from previous SIMMs. The newer SIMMs have 72 interface pins rather than the 30 of previous SIMMs. This is only significant in that the newer SIMMs are not compatible with older systems and vice versa.

A newer DRAM has emerged which provides at least a 10% improvement in performance over standard DRAMs. EDO DRAMs are being seen in some high performance systems, and they can be produced without a significant cost increase over current DRAMs. The push for EDO has been driven by the increased clock speed of Pentium® processors and equivalent processors like the K5® from the Advanced Micro Devices (AMD) Corporation. As noted above, EDO is just a transitional solution. The significant increase in clock speeds has driven manufacturers to search for other solutions such as the SDRAM. The downside of this evolution is that increased clock speeds cannot provide significant performance increases without matching increases in RAM speeds.

Requirement: Minimum of 24 MB of RAM with a maximum access time of 70 ns.

Recommendation: Windows NT is a DII COE supported operating system. Serious consideration should be given to using 64 MB of RAM. Insure that the newer 72 pin DRAMs are being used. The type of RAM used in newer systems may have a significant effect on the performance of the system as a whole. Insure that if newer, high speed processors are being specified, that the newer types of RAM are also specified.

4.5 Expansion Bus

Component	Requirement/Specification	Recommendations
Expansion Slots	Minimum of 3 local bus slots and 2 PCMCIA slots	PCI local bus *Used in Pentium and newer systems(32/64 bit applications).

The purpose of a bus is to provide a path for information to move from the microprocessor (CPU) to the other components of the system (e.g., memory, video, disk storage, etc.) Originally this was accomplished using a single I/O bus which placed all memory and I/O devices on the same bus. This was the configuration for the first industry standard bus, the Industry Standard Architecture (ISA) bus.

4.5.1 Industry Standard Architecture Bus

As processors became more powerful, the bus became a bottleneck for information flow. This was remedied when systems designers at Compaq redesigned the standard PC architecture and added a separate bus for memory. All current ISA-based PCs have adopted this architecture--a separate bus for high-speed memory and another for I/O expansion.

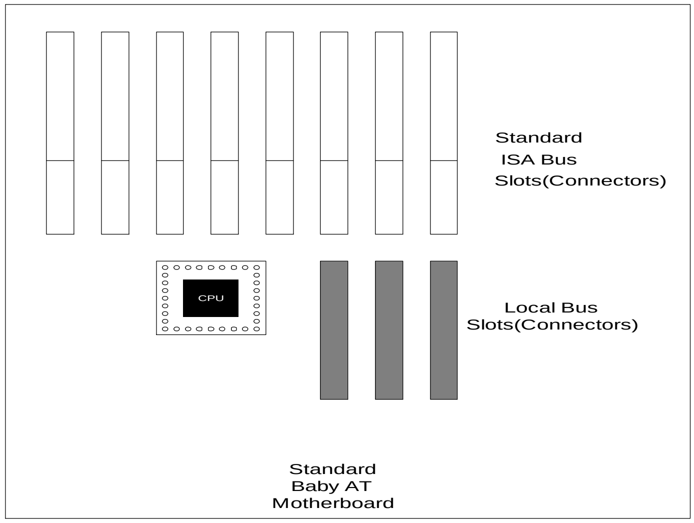
The ISA expansion bus has undergone several redesign attempts, but none of these efforts significantly improved the problems of bus throughput. As microprocessors became more powerful, there became an increased demand for graphical software and high resolution video. It became readily apparent that the standard bus would not be able to provide the performance to match the capabilities of the processor and the video devices. Microprocessors could generate screen data at speeds approaching 132 MB/second, but the ISA bus could only support transfer rates of 8 MB/second. This is a severe limitation for PC graphics. A standard VGA 16 color screen contains approximately 150 K of data. Using True Color (24-bit) with a resolution of 1,024 x 768 pixels, a screen contains approximately 2.3MB of data.

4.5.2 Local Bus

The solution to support high speed peripheral devices has been to add a third bus that is connected to the CPU and is matched to the speed of the CPU and the data output (32 or 64-bit). This solution is generically referred to as the local bus. While this solution was initially used to solve video performance problems, it can be used to improve the performance of any high speed bus connected device.

Since high speed video drove the requirement for the local bus, it was only logical that the first local bus standards were written by the Video Electronics Standards Association (VESA). The VESA standard is commonly referred to as the VESA Local Bus or VL bus. Another standard has been developed by Intel and is gaining broad acceptance as the primary standard. The Intel standard is referred to as the Peripheral Component Interface (PCI). Both standards have been upgraded based upon the implementation of the 64-bit Pentium® processor. While a local bus actually augments the expansion bus, the PCI local bus has the potential for replacing the ISA bus as the primary expansion bus. PCI is rapidly replacing the VL bus as the bus of choice.

The requirement for a local bus is driven by the requirement for high speed/high resolution video and for other high speed peripherals. As noted, the current implementation is for the local bus to augment the standard ISA expansion bus. The following diagram shows the generic positioning of the local bus slots and the ISA expansion bus on a standard motherboard.



The requirement for three local bus slots has been derived by the need for high speed communications between peripheral devices and the system. Generally, the two most important local bus devices are the hard drive and the video/graphics accelerator. These items will benefit the most from high speed communications and their effect will be noticeable in system performance. The use of the local bus for supporting the network interface card will also enhance the system performance. While three local bus slots are the minimum requirement, having more local bus slots can provide greater potential capability. For the purposes of this report, the system, must have a minimum of three local bus slots. Upon delivery, two of these slots may be used for the hard drive and graphics but at least one slot should be available for other uses. The following section discusses the requirements for PCMCIA capability. It is important to note that unless a PCMCIA socket(s) is built into the mother board, the only way for a PCMCIA device to interface with a personal computer is for an adapter to be fitted to an ISA slot which will convert the slot to PCMCIA compatibility. Since two PCMCIA slots are required, then the system must be delivered with two ISA slots already configured to support PCMCIA.

Requirement: Minimum of three (3) local bus slots. One slot should be available upon equipment delivery.

Recommendation: Local bus slots be Peripheral Component Interface (PCI).

4.6 PCMCIA

The development of expansion bus capabilities for the personal computers has been mirrored by requirements to support expansion bus capabilities for notebook computers (also laptop and subnotebook computers.) Due to the size constraints involved, a new line of peripherals has been developed for notebook computers based on credit card-sized devices. Originally designed for memory expansion, these cards now support I/O devices like fax modems, network cards, etc. The interface specification standard is called the Personal Computer Memory Card International Association (PCMCIA).

The PCMCIA interface is designed to provide a connection between a small PC card (or PCMCIA card) and the host PC. The device may interface using a special adapter that connects the PC system bus (ISA/VLB/PCI) to the PCMCIA socket . It is also possible for a PC to have PC Cards PCMCIA sockets (or slots) installed on the motherboard.

PCMCIA cards vary in thickness and adapters or sockets must be identified by their capability to support particular cards. There are three standard card sizes which are identified by a type number--3.3 mm for Type I, 5.0 mm for Type II, and 10.5 mm for Type III. The most prevalent cards are Type II, which are used for flash memory, modems, LAN adapters, and sound cards. The thickest cards, Type III, are used for specialty cards like hard drives or radio modems. Most notebook computers provide a dual socket which will hold two Type I or II cards or a single Type III in one of the connectors.

In 1994, the Assistant Secretary of Defense for Command, Control, Communications and Intelligence, mandated that all future personal computers purchased by DOD must be equipped with two PCMCIA slots. The requirement to support PCMCIA slots is based on use of the FORTEZZA signature and cryptographic PC Card. The FORTEZZA card will be used throughout DOD for the protection of sensitive information. The card itself is a PCMCIA compliant (version 2.1) Type II card. The requirement has been further refined to require that the personal computers must be delivered with the capability to support two PC cards/devices.

This is a particularly important issue since you generally find PCMCIA devices being used with notebook computers not desktop personal computers. Since this requirement does not exist for non-DOD users, most personal computers will not have special PC cards. This is generally resolved by using a special adapter that connects the PC system bus (ISA/VLB/PCI) to the PCMCIA socket. The downside of this solution is the loss of two bus slots. As noted, the personal computer must be delivered with the PCMCIA capability configured for use. This means that the socket adapters must be installed and two bus slots dedicated to PCMCIA support.

Requirement: Minimum of two PCMCIA (version 2.1) Type II slots.

Recommendation: If available, have PC cards.

4.7 Hard Disk

Component	Requirement/Specification	Recommendations
Hard Disk	$ 1.0 GB burst transfer rate $ 11 Mbps	$ 3.0 GB E-IDE or SCSI-2

There are several factors that determine how well a particular hard disk will perform in a system. The first item that is generally addressed is size, or capacity. In the last several years, the price per MB of storage has been driven down significantly. This is good news since the storage requirements for modern operating systems and applications have increased sharply. But size is not the only factor in determining suitability. The performance of a disk drive is gauged on average seek time, average access time, and data transfer rate.

Average seek time is defined as the time the hard disk takes to move the read/write heads over the platter to a particular track. If the average seek time is coupled with the time it takes to get a particular memory location under the heads (latency), that is the *average access time*. In short, access time is the time it takes the hard disk to find a specific piece of data. On modern drives, the access times are in the 12.2 ms to 18 ms range.

The ***data transfer*** *rate* is also called the throughput. It represents the time it actually takes to read or write data to the disk once the heads have been properly positioned. While there are several ways to express data transfer rates, the most common is the burst data transfer rate. This specifies the rate at which data is read from the drive buffer. This rate will vary greatly depending upon the interface that will be used.

Up until a couple of years ago, there were basically only two choices for hard drive interfaces--the Integrated Drive Electronics (IDE) or the Small Computer Systems Interface (SCSI). The IDE interface is also referred to as the AT attachment (ATA) interface. These terms are synonymous and are used interchangeably. Initially, the choice between IDE and SCSI was rather innocuous. Both interfaces provided relatively equal speeds, but each had its separate strengths. IDE was simple and inexpensive to implement. The SCSI interface is the implementation of the ANSI standard (X3T9). SCSI required a special controller but supported a lot of devices on a single cable. IDE found its way into most PCS, to support hard drives while SCSI was used to support CD-ROMs and hard disks. Due to its ability to support up to seven devices on single SCSI port, SCSI was the interface of choice for servers.

Both the IDE and SCSI interfaces have undergone significant improvement. IDE is giving way to Enhanced Integrated Drive Electronics (E-IDE), which provides significant improvements. IDE was limited to hard drives less than 528 MB, while E-IDE can support 8.4 GB per drive. E-IDE can support up to four drives per system while IDE only supported two. More important, E-IDE is capable of supporting disk drives, CD-ROMs, and Tape Drives. While E-IDE can provide significant performance improvements, it is important to know what standards are implemented on your E-IDE interface. Transfer rates can vary dependent upon what standards have been implemented. Some manufacturers have chosen not to use the E-IDE label but have chosen the acronym Fast ATA for high speed drives (11.1 or 13.3 Mbps) and Fast ATA-2 for the faster drives (16.6 Mbps).

SCSI still is the interface choice for servers and has several new flavors including SCSI-2 and Ultra SCSI. SCSI-2 is the implementation of the 1991 revision to the ANSI X3T9 standard which defined a new Common Command Set for the X3T9 standard. SCSI-2 can be implemented using an 8-bit bus or a 16-bit bus with transfer rates of 10 Mbps and 20 Mbps, respectively. Ultra SCSI can provide 20 Mbps on an 8-bit and 40 Mbps on a 16-bit bus.

It is important to remember that each of these interfaces will suffer significantly when used with the normal ISA bus. It is best to use these devices with a local bus to get the best throughput.

Requirement: $1.0 Gb, E-IDE or SCSI-2, burst transfer rate $ 11 Mbps.

Recommendation: System should be configured to allow for hard drive to use local bus for maximum performance.

4.8 Video

Component	Requirement/Specification	Recommendations
Video	SVGA, Graphics Accelerator with a minimum of 4 MB RAM, refresh rate $ 72 Hz, noninterlaced, support for 1024x768 resolution, PnP	VRAM, Local Bus Video, 64-bit Graphics Accelerator

The video adapter is one of the most important items in a computer's configuration because it controls exactly how the user sees his display. Considering this, the video arena has not had the significant improvements seen in other computer components. While resolution and color have improved dramatically, these improvements are basically incremental enhancements of existing technology.

The previous video requirements for the minimum configuration were expressed in display capability (SVGA) which provides 256 colors of display with a resolution of 1024 x 768. While this seems adequate, the graphical nature of the new operating environments has changed this requirement. The new graphical operating systems and applications need greater color capability and faster performance out of the display systems.

An SVGA controller with 1 MB RAM is limited to 256 colors with 1024 x 768 resolution.

Focusing on the resolution ignores the key performance issue--how fast can the image be generated. Graphics adapters do not produce graphic objects. They rely on the CPU to do the actual generation. With a standard SVGA controller, the CPU passes the graphical information to the controller via the ISA bus. As noted previously, this is what lead to the development of the local bus. The local bus is needed to pass the huge amounts of graphical information at greater speeds to the controller. This alone does not provide adequate performance to match the graphical requirements of current operating systems and applications. What was needed was to push the actual object generation to another special processor in order to "accelerate" the generation of graphics.

The graphics accelerator is designed to do this work. The CPU generates the end points and color for a line. It then passes this information to the accelerator (via the high speed local bus), and the accelerator then does the actual line drawing in video RAM. This is a simplified explanation, but the concept is the same for more complex objects.

Current graphics accelerators are packed with memory and capable of resolutions from 640 x 480 to 1280 x 1024 pixels. Coupled with this high resolution capability, there is the capability to display 16.7 million colors. The type of memory that is used in the graphics accelerator is dependent upon graphics requirements and the capability of the monitor. The size of the monitor directly affects the usable resolution of the display and the depth of color that can be supported. A normal monitor (15-inch) can be used to display 800 x 600 resolution. With 1 MB of RAM, the accelerator can generate 64,000 colors with the 800 x 600 resolution. A 17-inch monitor can handle a greater resolution (1024 x 768) but needs 1.5 MB of RAM to support the same 64,000 colors. The bottom line rule is that higher resolutions need more video RAM to support color depth. This can be mitigated by the type of memory used with the accelerator. Normal memory DRAM is best for medium resolutions (1024 x 768) and color (256K), but special video RAM (VRAM) will be more efficient for higher resolutions with greater color depth. VRAM allows the system to receive CRT inputs while still receiving video outputs from the CPU or from the accelerator chip. This is more efficient and produces greater video performance. Significant improvements in video display are being implemented at a very high rate. New RAM is being introduced to expand on the success of VRAM. The new Window RAM is a incremental improvement that increases the performance of the video accelerator. While the minimum requirements are provided below, new technologies may surpass these requirements at a much cheaper cost.

The video capabilities of the minimum desktop personal computer system are driven by the GCCS requirement to display high resolution graphics such as detailed terrain maps. This will require a video capability to display a minimum resolution of 1024 x 768 pixels with True Color (16.7 million colors).

It is important to remember that the capabilities of the Graphics Accelerator must be matched by those of the monitor. A high performance Graphics Accelerator matched with a 14-inch VGA monitor will provide a mediocre video display to the user. Monitor requirements will be discussed in the next section.

<u>Requirement</u>: SVGA, Graphics Accelerator with a minimum of 4 MB RAM, refresh rate $ 72 Hz (noninterlaced) and support for 1024x768 resolution. The board must be plug and play compatible.

<u>Recommendation</u>: To provide sustained high performance graphical capabilities with the maximum color depth, the graphics accelerator should use Video RAM (VRAM) vice normal DRAM memory. A 64-bit graphics accelerator is recommended for graphic intensive operations.

4.9 Monitor

Component	Requirement/Specification	Recommendations
Monitor	17-inch #.28mm dot pitch, refresh rate $ 72 Hz, noninterlaced Plug and Play compatible	Anti-Glare coating Digital controls

Technologically speaking, it does not appear that cathode-ray-tube technology has changed much over the last couple of years. Except for size, there appears to have been little or no change on the desktop. In actuality, monitors have changed significantly internally and externally (display). The displays are actually sharper, brighter, glare resistant, and have less distortion. In addition, there have been significant improvements in energy efficiency and emissions control. When defining monitor requirements, the size of the display screen has a direct correlation to the resolution that can be comfortably displayed. The standard 14-inch monitor is capable of displaying 1024 x 768 pixels, but the size of the icons and text will be reduced by 40 percent compared to a resolution of 640 x 480 pixels. In essence, more information is being put in the same viewing area by shrinking the size of the objects. This generally renders the images/text unreadable. A 15-inch monitor is only slightly better because resolutions of 800 x 600 are very legible. In order to achieve legible resolutions of 1024 x 768, a 17-inch monitor is required. Most 17-inch monitors will support legible resolutions of 1280 x 1024--more than four times the viewing area of VGA (640 x 480). Unfortunately, monitors are measured in two different ways: the diagonal measure of the picture tube (always the larger number) and the diagonal measure of the *viewable* screen area (always smaller than the diagonal measure of the tube). For example, a standard 17-inch monitor can have a viewable screen area diagonal measurement of anywhere from 14 to 16 inches. There is no industry standard as to what defines a 17-inch monitor. As a result, most manufacturers now state the viewable screen area diagonal measurement in addition to the picture tube measurement. For the purposes of this document a 17-inch monitor should have a diagonal viewable measurement of not less than 16 inches.

Besides resolution and size, there are several other factors that must be considered. The most important is dot pitch or the measure of the distance between adjacent phosphor dots of the same color. The more dots that go into each pixel, the better the display can resolve fine details. The smaller the dot pitch, the better. The maximum acceptable dot pitch for 15 and 17-inch monitors is .28.

While there are other video considerations that should be evaluated when selecting a monitor, the only other issue that will be addressed here is refresh rate. Refresh rate is the vertical scan rate of the monitor or more precisely, how long it takes the electron beam to scan from left to right, one line after another, until it has painted the complete screen image and starts again. The refresh rate is measured in hertz (Hz). The practical effects of a poor refresh rate is screen flicker. For the resolutions required by this document, a monitor must have at a refresh rate of at least 72 Hz in a noninterlaced mode. Noninterlaced means that the screen is refreshed by each line of the display in sequential order. In an interlaced monitor, every other line (horizontally) is refreshed so that it takes two complete passes or cycles to repaint the entire screen. This can result in a significant screen flicker.

The monitor should have display data channel (DDC) support to meet the requirements of "plug and play". (See section 4.17).

The only other requirement that will affect monitor selection is the requirement to comply with the EPA's Energy Star requirements. Appendix B gives a more detailed explanation of these requirements and how they are implemented.

Requirement: $ 17-inch measured diagonally
(minimum diagonal viewable measurement of 16 inches).
Maximum of .28 dot pitch (Lower values represent better quality).
Minimum of 72 Hz refresh rate (higher values represent better quality).
Noninterlaced.
DDC support for plug and play compatibility.
EPA Energy Star compliant.

Recommended:

Anti-Glare coating.
Digital controls.
MPR-II compliance (EM emissions protection).

4.10 Interfaces

Component	Requirement/Specification	Recommendations
Interfaces	2 serial (16550 UART) 2 parallel	EPP, ECP

The parallel and serial ports provide a computer's interface to the outside world. Generally, they are used to connect printers, modems, and pointing devices to the computer. Recently, they have undergone significant change, and not all ports/interfaces are equal.

4.10.1 Parallel Port

The parallel port has historically existed to serve one purpose--connection of a printer to the computer. In today's networked environment, the parallel port is generally not used for supporting a printer but to serve a multitude of other devices that need a parallel port to operate. If a personal computer is not used in a network environment, the most common practice is to use special parallel port adapters which will allow pass-through printing. That is, printing information passes through the adapter and onto the printer while other information is filtered out and sent to the appropriate peripheral device. Originally, the parallel port requirement was for unidirectional communications only--that is, information was sent to the parallel port, but no information was passed back through the parallel port to the computer.

While the parallel port provides the highest speed interface to external resources (40 Kbps to 300 Kbps), it suffers from performance limitations. External devices now provide significant performance increases over the initial printer requirements. In 1991, a coalition composed of Intel, Zenith, and Xircom developed a new parallel port specification, the Enhanced Parallel Port (EPP.) The specification for the EPP has been revised and the current release (v1.7) has been submitted to the IEEE as a proposed industry standard. The EPP, in theory, is capable of transferring data at five to ten times that of the original AT parallel port. In actual implementation, the EPP doubles the transfer rate of the standard parallel port. At the same time that the EPP specification was being developed, Microsoft and Hewlett-Packard were also developing a specification for a new parallel port. Dubbed the Enhanced Capabilities Port (ECP), this port not only offers significantly more performance than the standard AT parallel port, it goes beyond the EPP specification by offering the potential of daisy-chaining multiple devices on the parallel port. Microsoft has designed Windows 95 to take advantage of the speed of the ECP but has not implemented any multiple device support.

As noted, the requirement for the parallel port to support a printer is no longer a major factor due to the use of network printers. Therefore, the need for two parallel ports has been reduced to a single port to support other devices. In cases where a personal computer has a requirement for two parallel ports, they can easily be added using a dedicated Input/Output card.

4.10.2 Serial Port

While the parallel port will always be thought of as the printer port, the serial port will always be thought of as the universal port. The serial port is commonly referred to as the communications port or, according to its electronic specification, the RS-232 port. The heart of the serial port is the chip that is responsible for transforming the parallel bus signals into a stream of serial pulses. This chip is called the Universal Asynchronous Receiver/Transmitter or UART. The most important thing to remember about the UART is that it is identified by a numerical designation. The higher the number the greater the performance and throughput. The current state of the art is the 16550 UART, which is necessary to support high speed transfers. This is of particular importance when connecting modems with transfer rates of 14.4 kbps or higher.

Requirement: minimum of two parallel ports and two serial ports (16550 UART).

Recommended: ECP or EPP parallel ports.

4.11 Floppy Disk

Component	Requirement/Specification	Recommendations
Floppy Disk	one 3.5-inch, 1.44 MB Drive	Combo Drive

The state of the art for floppy disks has not advanced significantly over the last few years, and it is unlikely that it will change much in the next few years. While several manufacturers have pushed 2.88 MB floppy drives, these have not gained wide acceptance. The newest innovation is the combo drive which combines a 5.25-inch drive and a 3.5-inch drive in the same housing thus saving a drive bay. The single unit has separate openings for the disks themselves with the 3.5 inch opening positioned above the 5.25 inch opening. If there is a requirement to be able to access both types of floppy disks, then a combo drive is the best solution.

Requirement: one 3.5-inch, 1.44 MB Drive.

Recommended: Combo Drive if required to support two sizes of drives.

4.12 Pointing Device

Component	Requirement/Specification	Recommendations
Pointing Device	mouse (minimum 3 buttons)	optional trackball or touch pad

It has become almost impossible to use new graphical applications without a mouse or similar device. All new mouse devices should be configured with a minimum of two buttons. For a time, a mouse with three buttons was the de facto standard. It was anticipated that the third button would take on some mandatory feature in windowing systems. This has not come to pass. While the newer windows systems allow the third button to be configured as a system specific button or a "shortcut" button, its use is not mandatory. Trackballs have become very popular with larger sized monitors displaying greater resolutions. The trackball allows the user to cover more screen area without having to move the device. If a trackball is used, it should also support at least two buttons.

A number of new pointing devices have emerged due to the increase in use of notebook computers. These devices reduce the space required to operate a pointing device. One of the newer technologies is the electronic touch pad. The touch pad can be found under many different names from TouchPad, QuePoint or Glidepoint. Whatever the name, the concept is the same--they allow you to control the cursor with your finger. About the same size as a mouse, touch pads are flat rectangular devices that use a very weak electrical field to sense your touch. As you move your fingertip, the cursor follows the movement. You click by tapping your finger on the pad’s surface or in some cases, pressing buttons located around the pad. These devices have significant benefits with some drawbacks. The greatest benefit is that like the track ball, the touch pad requires less movement of the arm in order to control the cursor and because of this, it requires less physical space on the desktop. In fact, both the trackball and the touch pad have found their way onto some keyboards. This is a distinct advantage in cases where desktop space is at a premium. The downside is that both the trackball and the touch pad require different arm movements than we are accustomed to with the mouse. Some people will never be able to convert from using a mouse to using a touch pad or trackball. While others will find these the perfect pointing device, it is very much an individual selection.

Both the trackball and the touch pad are excellent alternatives to a mouse particularly where space is a problem and where larger resolution monitors are used. These devices should be considered as optional selections in a system configuration.

The mouse/trackball can be implemented using a serial port or via a bus connection. The problem with a serial mouse is that it takes up a scarce resource--the serial port. A bus mouse can also be implemented using an add-in board which slips into an expansion slot. Both of these implementations cause you to give up some resource--a serial port or an expansion slot. The best method is to have a dedicated mouse port for the computer. This is generally implemented as a PS/2 style port and does not interfere with any other port or require an expansion slot.

Requirement: Mouse with a minimum of three buttons.

Recommended: Option of selecting a trackball or touch pad instead of a mouse.

4.13 Keyboard

Component	Requirement/Specification	Recommendations
Keyboard	101 Keyboard	Optional ergonomic keyboard or integrated pointing device. NOTE: Win 95 has 104 key keyboard.

While it is probably the most used item on your desktop, the keyboard gets very little attention during the procurement process. Due to the attention given the keyboard because of Repetitive Stress Injuries (RSI) the keyboard has seen some ergonomic modifications but the keyboard layout has not basically changed from the QWERTY style.

The original typewriter keyboard was invented in 1867 by Christopher Sholes. The first keyboard had the keys arranged alphabetically but within a couple of years Sholes discovered the QWERTY layout. There are several common myths surrounding the selection of the QWERTY layout but most of them do not provide any insight as to why this particularly layout was selected. To complicate matters, the Shift key was not added to the basic design until 1878. Until that time, the typewriter did not permit lowercase letters. Needless to say, this even deepens the mystery of the QWERTY layout. While several attempts have been made to rearrange the alphabetical keys, they have not gained wide acceptance.

The modern 101 keyboard was introduced in 1984, with the introduction of the IBM AT computer. This keyboard expanded on the original AT 84-key keyboard. The additions were a new dedicated cursor control pad (arrow keys) separate from the combined numeric/cursor pad, a small cluster of control keys (page up/down, home/end, and insert/delete), and an additional two function keys (F11 & F12) were added to the original 10 function keys. In addition, duplicate Ctrl and Alt keys were added.

What is important is that applications and operating systems have been developed that make use of these keys. The loss of any of the keys will probably affect a portion of the user community. The 101 keyboard is the basic minimum configuration. Other special keyboards have been designed that add more special control keys but the 101 remains the minimum layout. With the advent of Windows, particularly Windows 95, some new keyboards have been developed that have additional function keys with Windows functions/short cuts assigned to them.

Ergonomic keyboards have been designed that help reduce the stress placed on the wrists (Carpal Tunnel) but they have not yet gained great acceptance. These work by elevating the face of the keyboard and by separating the keys into two groups: QWERT on one side and YUIOP on the other. This significantly changes the carriage of the wrist by moving the fingers higher than the wrist and angling the fingers inward (bringing the wrists and elbows out). These have been very effective but they are add-on costs which can be significant. One alternative to this design has been the development of wrist cushions that extend across the bottom of the keyboard. These cushions also change angle of the stress placed on the wrist but don't separate the keys. As noted, none of these developments has been widely implemented because of resistance to change and cost. These alternatives can bring relief to suffers of RSI and can avoid future RSI problems.

One keyboard development that has gained widespread acceptance is the addition of a pointing device to the keyboard. Trackballs and touch pads have been added to the keyboard in order to save space on the desktop. The addition of touch pads is a current trend that seems to be on the upswing. Keyboards like these should be considered as an option for areas that have significant space limitations.

Requirement: Keyboard with 101 keys.

Recommended: Option of selecting an ergonomic keyboard or keyboard with integrated trackball or touch pad.

4.14 CD-ROM

Component	Requirement/Specification	Recommendations
CD-ROM	minimum of 12X speed ISO 9660 compliant	16X speed * Recommend 24X for future systems.

Compact Disk Read-Only Memory (CD-ROM) is probably one of the fastest growing segments of the computer environment. All fully featured PCS are equipped with a CD-ROM. The ability to store such large volumes of information has had significant impact on information systems. A typical disk has a capacity of 680 MB or more. The standard format for CD-ROM disks is ISO 9660. ISO 9660 embraces all forms of data likely to be encountered including audio and video information. Any CD-ROM reader selected for computer use should be ISO 9660 compliant.

The original CD-ROMs were based on audio CD technology. This technology provided a data transfer rate of 150 Kilobytes per second (Kbps) with an access time of 50 ms. While this speed is sufficient for audio CD systems, it does not fit the requirements for video. CD-ROMs based on the initial audio CD capabilities are referred to as single speed units. The nominal speed of a drive refers to its effective data transfer rate. Since these rates are compared to the initial rate of 150 Kbps, they are referred to as multipliers of that speed. For instance a quad speed drive is capable of a data transfer rate of four times a single speed (12 x 150 Kbps) or 3000 Kbps. Transfer rates change in increments of double values. Examples of current drives are 2X, 4X, 6X, 8X, 12X and the newest 24X.

The requirement for CD-ROM capabilities has been generated by the fact that bulk data (like map detail and reference files) are being distributed on CD-ROM. In addition, the newer graphical operating systems like Windows NT and Windows 95 are being distributed on CD-ROM. This is more efficient since it would take more than 20 floppy disks to load the equivalent data that is on a single Windows 95 CD-ROM.

What speed CD-ROM is required? The current state of the art is with 16X starting to make significant inroads. Single speed CD-ROM units are obsolete since they cannot support the rapid transfer rates required for video and graphics applications. Manufacturers are now distributing software that requires a double speed CD-ROM to run because a single speed unit cannot provide adequate transfer rates. Double speed CD-ROMS were replaced by Quad speed CD-ROM drives and the new common standard will most likely be the 16X CD-ROM drive. Speed is less of a factor for tasks like installing software or doing database searches. Speed is a significant factor when selecting a CD-ROM for multimedia use.

A CD-ROM drive can use either a SCSI or IDE interface. While SCSI provides greater performance, IDE is more cost effective. Now that the newer E-IDE interfaces are available, it is possible to operate a CD-ROM off the same controller as the hard drives and floppy disk. This will simplify computer configuration.

It is important to note that CD-ROM technology is changing very rapidly, particularly in the area of transfer speeds. While the speeds shown in this section are accurate for the current time, they may be obsolete in a few short months. This is particularly important since there is very little cost differential between the different speed CD-ROM drives. Currently, there are very few applications that mandate that a particular speed CD-ROM be used. It is more of a performance choice rather than a failure mode decision. This may change as applications become more multimedia oriented. Anyone procuring CD-ROM drives should balance the recommendations in this report against the equipment available at the time of the procurement.

Requirement: $ 12X speed, ISO 9660 compliant.

Recommended: $ 16X for multimedia use.
* Recommend 24 X for future systems.

4.15 Additional Features/Components

The following features/components are found in nominal personal computer configurations. While they are not strict requirements for every DOD personal computer, they should be considered components of any standard desktop environment.

4.15.1 Audio

Component	Requirement/Specification	Recommendations
Audio/Sound Card	Sound Blaster v3.0 compatible True Stereo Output Plug and Play compatible	Application Specific
Speakers	Amplified Speakers 3 to 5 Watts output	Magnetically Shielded
Microphone	unamplified	Application Specific.

While the items listed here are addressed as separate items, they are generally procured as a suite of equipment. The speakers and microphone may not be adequate for more sophisticated audio requirements and should be evaluated on a application basis. As a minimum, they should be included in any audio package. The audio requirements for multimedia support can be found in JIEO Report 8303, *Multimedia Extensions to the DOD Minimum Desktop Configuration*.

4.15.2.1 Sound Card

Every computer system comes equipped with a PC speaker and the capability to generate sound. The question of sound comes down to the quality of the sound produced. To get even the minimal sound quality from a computer, it must be augmented by a sound board/card. The sound board connects via a normal expansion slot and is basically a circuit board with special audio circuitry. The quality of the sound produced is in direct proportion to the capabilities of the particular board. There are numerous methods for sound replication, such as FM synthesis and wave table synthesis. The quality of the sound produced by the sound board is not necessarily a product of the type of synthesis but more a factor of quality of the synthesizer.

Two ad hoc standards for synthesizer quality have emerged over the last few years. The original ad hoc standard was the Ad Lib sound board. Any implementation that could mimic the Ad Lib board was considered the minimal requirement. Ad Lib was the ad hoc standard until the Sound Blaster board entered the market. The Sound Blaster met the minimum standard of being Ad Lib compatible and eventually supplanted Ad Lib as the ad hoc standard. Most sound boards are now measured against the capabilities of the Sound Blaster version 3.0. This standard reflects a 16-bit sound card capable of playing 16 notes simultaneously and providing true stereo output.

Low cost video teleconferencing is finding its way to the desktop in a lot of organizations. In order to accomplish video teleconferencing, the sound card will need to support full duplexing (i.e., so you can talk and listen at the same time, like on a telephone). As you place more optional equipment into the personal computer, the system configuration becomes more difficult. Sound cards have a lot of capability but require good configuration management in order to operate properly. As noted in section 4.14, the sound card should be Plug and Play compatible.

4.15.2.2 Speakers

Audio quality will not match the capabilities of the sound board unless the sound board is supported by a pair of quality speakers. This is another area where there are no particular standards, and speaker quality/performance can vary greatly. One specification that must be met to produce quality sound is that the speakers must be amplified to provide any level of quality performance. This will require that your speakers have a separate power source (other than the voltage from your sound card). As with any audio speaker, the output of the speaker is measured in watts per channel, the higher the wattage the greater the power. Generally, a power output of 3 to 5 watts should suffice for the average user. In addition, speakers should be magnetically shielded so they don't affect other components of your computer system.

4.15.2.3 Microphone

A PC audio suite is not complete without a microphone to make use of the Windows recorder (3.1 or Windows NT). At the bottom end of the scale, the inexpensive unamplified microphones that are provided with sound cards are adequate for casual voice recordings. As with any other device, the actual qualitative requirements are application specific. A microphone should be provided as part of any audio package but for more sophisticated audio capabilities may require a higher quality device. This requirement may become more important as low cost video teleconferencing becomes available to more users.

Requirement:	Sound board that is, at a minimum, Sound Blaster v3.0 compatible. Plug and Play compatible. Multimedia speakers (amplified). Microphone (unamplified).
Recommended:	For multimedia applications, evaluate all potential board, speaker, and microphone combinations against particular requirements. Speakers should be magnetically shielded and have a power output of 3 to 5 watts.

4.15.3 Modem

Component	Requirement/Specification	Recommendations
Modem	$ 28.8 Kbps under V.34bis V.42bis compression/error correction Hayes AT compatible CCITT (ITU) Group 3 Fax Plug and Play compatible	33.6 Kbps under V.34 V.42bis compression/error correction Hayes AT compatible CCITT (ITU) Group 3 Fax Internal, PnP

Modems have become a standard device for today's desktop environment. For non-networked systems, it provides the main communications line to the outside world. While modems have made significant advances in the last few years, they are somewhat limited by the quality and speed of the communications lines that are used to support them. The rise of the Internet has driven the need for high speed communications from the desktop. Telecommunications devices are driven by more standards than any other device on the desktop. This is because they interoperate with a tightly controlled environment--the telephone system. The telephone system must be interoperable anywhere on the globe so standardization is a basic requirement. An international telecommunications organization was established to develop standards for telecommunications equipment and protocols. Originally, this organization was called the International Telegraph and Telephone Consultative Committee (CCITT). The name has been changed to the International Telecommunications Union or ITU. The initials CCITT will be encountered more often than ITU, but they are synonymous.

The following key features/characteristics are required:

Speed: 28.8 Kbps under the V.34bis standard.

The speed of a modem determines how quickly data can be transmitted over the communications line. In order for high speed modems to be effective, the modems at each end of the communications line must be capable of supporting the highest transfer rate. For example, if a 28.8 Kbps modem is transmitting on a line, and the receiving modem is only capable of supporting 14.4 Kbps, your effective transfer rate will be 14.4 Kbps. Each modem is capable of determining the high rate that the other modem can accommodate and thus will automatically adjust the rate at which the data will be transmitted. This makes modems downward compatible and ensures that newer modems can operate with older versions.

The ITU rates high speed modems using a "V.XX" label. The standard high speed modem has been the V.32 or 14.4 Kbps modem. The newer V.34 or 56 Kbps modems are rapidly being fielded. The minimum value for the desktop configuration is the V.32 but this is an absolute minimum, and the V.34 is the better choice and will soon be the minimum standard. The V.34bis standard extends the V.34 standard to 56 Kbps.

Compression: V.42bis.

There is no method for increasing the transmission rate of a telephone line past the capacity of the channel. What can be done is to the make better use of each bit of information. Certain characters do not pass meaningful information other than format or indicating the lack of data--like a space or a zero. The process for making information more meaningful is called data compression. The previously used standard for data compression is the Microcom Networking Protocol class 5 or MNP5. The newer standard is the ITU V.42bis. This protocol is more efficient than the MNP5 protocol and has international recognition. The only issue to be noted is that the two compression protocols are incompatible, so a V42bis-only modem cannot communicate with a MNP5-only modem. The network must be homogenous when it comes to data compression, or the modems must support both protocols.

Error Correction: V.42.

Due to line noise and other factors, errors can be introduced into a data stream during transmission. Errors can be detected and corrected by several schemes at the receiving station. This generally involves adding parity bits in the stream as checks. The international standard for error correction is the ITU V.42, and this should be implemented on all modems.

Command Set: Hayes AT compatible.

The communications software running on the computer must be able to control the actions of the modem in order to communicate with external resources. In addition, the modem must have a way of synchronizing communications with other modems. This is accomplished using a set of commands that controls the actions of the modem and allows the modem to send synchronization commands to the computer and other modems.   The Hayes company developed a command set for its line of modems that has become the de facto standard. If a modem has implemented this particular command set, then it is considered to be Hayes compatible. All modems used with the minimum personal computer configuration should be Hayes compatible.

Fax: CCITT (now ITU) Group 3 Fax.

The use of Facsimile transmission has become routine in today's world. Almost every modem sold today supports fax transmissions. While several fax protocols were used in the past, they were basically analog. These fax systems were called group 1 and group 2 and differed only in speed. In 1980 the ITU (formerly CCITT) adopted the group 3 fax protocol that makes all fax transmissions digitally based. This has increased the speed of fax transmissions from the old 300 baud to 14.4 Kbps, or 28.8 Kbps in newer modems. It is important to note that data and fax modems operate under different standards and in some cases a fax transmission will transfer information at a much slower rate than a data transmission. All new modems should support ITU Group 3 fax.

External or Internal?

Modems are available in both external and internal models. External modems are easy to move from computer to computer and it is easy to tell if the modem is active (or working properly) because the indicator lights are easy to see. In addition, the modem can be easily powered down because it has its own independent power supply. Conversely, external modems take up valuable desk space and require the use of a serial port.

Internal modems use an expansion slot and thus free up deskspace. In addition, they protect the modem from harm and do not require a serial port. They also isolate the user from any implementation issues because they do not need any external wiring. Conversely, to power down the unit, you must turn off your computer. In addition, it is difficult to determine how your modem is working because of the reduced size, there can only be a limited number of display lights.

The benefits of using an internal modem outweigh the benefits of an external unit. Unless implementation specific reasons exist for using an external modem, select the internal unit as a default. In addition, all modems should be Plug and Play compatible.

Requirement: $ 28.8 Kbps under V.34bis.
V.42bis compression/error correction.
Hayes AT compatible.
CCITT (ITU) Group 3 Fax.
Plug and Play compatible.

Recommended: 33.6 Kbps under V.34.
V.42bis compression/error correction.
Hayes AT compatible.
CCITT (ITU) Group 3 Fax.
Internal PnP.

4.16 Network Interface Card

In order to operate in the Defense Information Infrastructure, all desktop computers must have a networking capability. The network interface card provides the connection between the computer and the external network. The physical implementation of the interface depends upon the type of network architecture that has been installed. For the purposes of the minimum desktop personal computer configuration, the physical interface is not significant as long as it supports the TCP/IP suite of protocols. The Joint Technical Architecture (JTA) will address the minimum LAN configuration and is currently describing a requirement for IEEE 802.3 (Ethernet) 10Base-T (also known as ISO 8802-3). The card itself should be a 16 bit ISA bus card but a local bus card would be preferred.

While most people refer to TCP/IP as a protocol, it actually refers to a suite of data communication protocols. It is referred to as TCP/IP because of two of the protocols that belong to the suite; the Transmission Control Protocol (TCP) and the Internet Protocol (IP). If you look at this suite of protocols in a layered view, as in the OSI model, you get four distinct layers (Table 4-5). The DOD Protocol Model as described in the DDN Protocol Handbook only describes three layers, but does not include the Internet layer. Table 4-5 provides a realistic view of the TCP/IP protocol hierarchy.

4	**Application Layer**	Consists of applications and processes that use the network.	**SMTP, Telnet, FTP, etc.**
3	**Host-to-Host Transport Layer**	Provides end to end data delivery services.	**TCP, UDP, ICMP**
2	**Internet Layer**	Defines the datagram and handles the routing of data.	**IP**
1	**Network Access Layer**	Consists of the routine for accessing physical networks.	**Ethernet, FDDI, ATM, etc.**

Table 4-5. TCP/IP Protocol Hierarchy.

Unfortunately, the TCP/IP suite of protocols is defined by standards that are addressed in three different documents. In addition, the TCP/IP suite defined by a set of protocols, some of which are mandatory and some are optional. Therefore, it is important to be explicit when defining a requirement for TCP/IP.

For the purposes of this document the requirement must be expressed as TCP/IP with a specific requirement for support of the Simple Network Management Protocol (SNMP). SNMP is required for the network management function in GCCS and will be adopted as a requirement for all network management for DII systems. Support for other specific protocols has not been identified since the GCCS applications have not been fully analyzed and GCSS is still in the conceptual phase. It is anticipated that this requirement will be better defined by the next review of this document.

Requirement: Network Interface Card with TCP/IP (including SNMP) capability.

Recommendation: Compliance with JTA for LAN configuration.

4.17 Plug and Play

One of the greatest shortcomings of the personal computer is the lack of an automated configuration. With the addition of each peripheral device or expansion card, the configuration of the system becomes more complex. While some autoconfiguration was possible with the EISA bus and MicroChannel architecture, they fell short of the mark for true autoconfiguration. True autoconfiguration does not require the setting of dip switches or jumpers.

Plug and Play refers to the capability of adding a device to your system and having the system automatically configure itself to use the device. This means resolving any conflicts over ports, interrupts, and addresses. Implementing a true Plug and Play capability requires changes to current BIOS, expansion buses, expansion boards/devices, and the operating system.

The first step toward Plug and Play appeared in 1993 with the release of the Intel-Microsoft specification for the Industry Standard Architecture. Additional work was done on expanding this specification to the SCSI expansion. Several months after the release of the Plug and Play specification, Compaq and Phoenix Technologies joined with Intel to develop the BIOS specification. With the release of Windows 95, the final requirement was met--an operating system with Plug and Play support. While the use of the feature under Windows 95 has not been problem free, there is no doubt that Plug and Play is here to stay and will make significant progress in the next couple of years.

Plug and Play really involves a three-step process. First the system checks to see what resources an expansion device needs. Next, it needs to resolve conflicts and coordinate assignments. Finally, it updates its configuration and provides the configuration information back to the device.

As noted, three components of your system must be updated in order to have true Plug and Play capability; the BIOS, the Operating System, and the Expansion boards. The updates to the BIOS have been accomplished and are available on many new systems, the updates to the operating systems have also been implemented with Windows 95 being the first operating system to provide Plug and Play features.

The updating of the expansion boards is a key roadblock to providing full Plug and Play capability. The expansion boards must support specific hardware features in order to support Plug and Play. The most important feature is the need for the board to inactivate itself so that it does not respond to normal control signals inside your PC. The board must disconnect itself from all system resources so that when it is inactive, it cannot possibly cause conflicts. The boards must also implement new onboard registers. In addition, the board must have specific circuitry for managing its configuration and the capability to interact with the BIOS. For example, the board must be capable of continuously monitoring signals on the bus. In addition, the boards must act differently depending upon their function in the system. Boards that are required for booting the system (i.e., video boards, disk controllers) must start up in an active status while the other boards that are not required for boot-up will inactivate themselves during boot-up. Once boot-up is accomplished, the boards will be activated, as required, by the system. This is contrary to the way current expansion boards work. Conventional expansion boards come online during the boot process using the resources assigned to them as power-on defaults.

Therefore, true Plug and Play capability won't be available until all of the expansion boards and devices implement plug and play features. If you have updated your system BIOS and are running a Plug and Play feature operating system, you will still have to accommodate non-Plug and Play devices. The Plug and Play BIOS and Operating System will configure Plug and Play boards/devices but non-Plug and Play devices will still have to be configured manually. Plug and Play compatibility is required for all new procurements. All new operating systems and operating system releases for personal computers will provide Plug and Play support.

Requirement: Plug and Play BIOS support.

5.0 SUMMARY

The minimum desktop personal computer configuration will satisfy the requirements of the major DOD-wide systems. This configuration should be used when purchasing personal computer systems for DOD use. As noted, the minimum desktop personal computer configuration is the DOD baseline for a personal computer that will support all of the DII systems. Procurement specifications for personal computer systems to support DII may exceed the requirements outlined in this document, but they should not be reduced.

This report will be reviewed annually and updated if there are any changes to the requirements.

APPENDIX A

BENCHMARKING PERFORMANCE

A.1 BACKGROUND

The rapid expansion of the personal computer marketplace has been matched by a proliferation of different systems and microprocessors. This rapid expansion left consumers trying to determine which processor or system was best for their needs. At first, the difference in performance between processors was so close as to be negligible or so far apart as to be easily discernable. This led to wild performance claims and much confusion. This, coupled with the significant cost of personal computers, placed the consumer at odds with the manufacturers. The consumer needed a method to make a valid cost/performance comparison between different processors/systems. They needed to buy the highest performance at the least cost to maximize their investment and not run out of capability as software progressed.

The measuring of the performance of a system is called benchmarking. It consists of running a suite of system and application operations and measuring the effectiveness of the system to accomplish the tasks in a given period. The development of the 386/486 processors generated the demand for better benchmarking. In addition, the fielding of more powerful operating environments like Windows generated a demand for the capability to determine what systems could provide the best performance for a windowing environment. Even now the old benchmarks are being upgraded to gauge the performance of the new high speed processor architectures and 32-bit operating systems/applications.

The reason that 32-bit software is causing a change in the way benchmarks are performed is that 16-bit and 32-bit software run differently on the same processor. For example:

- Sixteen-bit software has a higher environment overhead. It spends significantly more time managing resources (like memory segments). This can be attributed to the limitations of the 286 processor and DOS where memory was limited to a 64K address space.

- Thirty-two-bit software has a total of 4 GB of memory address space available, so it can spend more time on CPU related tasks that increase the speed at which tasks can be performed.

In addition, 32-bit software has created a new range of software features that are not addressed by older benchmarks. Some of the new software features that have significantly affected the ability to use old benchmarks are:

- Pre-emptive multitasking
- Multithreading/multiprocessing
- Better memory protection

The need for greater performance from personal computers led to the development of high speed components. These components are capable of supporting the high speed processing of the microprocessor and thereby, increasing the total performance of the system. It has developed to the point that the selection of the proper system components is as important as the selection of the processor. New benchmarks are available that will evaluate the performance of each individual component and the system as a whole. This report only refers to the results of benchmarks designed to measure microprocessor performance. These results are used as a relative indicator of a minimum performance level. As part of the acquisition process, acquisition officials should select an industry-standard benchmark suite for evaluating different systems and their components in order to make an informed decision. The selection of such a benchmark suite is the responsibility of the acquisition officials.

A.2 PURPOSE

The purpose of this appendix is to provide greater detail on the benchmarks that are used as performance indicators in the minimum desktop personal computer configuration. It will cover both the required benchmarks and the recommended benchmarks.

This appendix contains benchmark figures for numerous commercial products. These figures are used solely as representative examples and do not constitute an endorsement of any particular product or company.

A.3 SCOPE

This following benchmarks will be covered in this appendix:

Required:

SPEC95
CPUmark32
iCOMP

Recommended:

Winstone 96
Norton SI 32

In addition, an emerging benchmark, the Processor Performance Rating (P-rating) will be discussed.

The different benchmark suites generate values that are relative numbers. Since they are relative numbers, there are no particular measurement values associated with them (like bits per second or milliseconds). The values for two different benchmark suites cannot be compared to one another. For example, a CPUmark32 benchmark value of 317 cannot be compared to an iCOMP value of 435. They have no common reference point.

A.4 SPEC95

The System Performance Evaluation Corporation (SPEC) was established in the late 1980's by a coalition of UNIX vendors that saw the need to have a standard method for measuring system performance. The first SPEC benchmark suite was released in October 1989 and is referred to as SPEC89. The actual performance rating was referred to as the SPECmark89. This benchmark suite was upgraded in 1992 and is referred to as SPEC92. SPEC92 was essentially the same as the 1989 version but was upgraded in its evaluation of floating point operations. The actual benchmarks were established as two separate evaluations--an Integer (SPECint92) benchmark and a Floating point (SPECfp92) benchmark. The SPEC92 benchmarks gained wide acceptance and have been used as performance criteria for computer acquisition.

The SPEC92 Benchmarks have been under fire the last couple of years. Criticism has centered on the ability of manufacturers to "tweak" their systems and software to give erroneously high SPECmarks. Compiler writers were able to insert pre-compilers in systems in order to improve performance ratings. Another criticism has been that the benchmarks themselves contain errors that invalidate some results. This criticism was validated, and the benchmarks have been updated to correct the errors. Guidance has been distributed that assists in normalizing previous results with the newer, corrected results.

Probably the most valid criticism of SPEC92 is that it did not keep pace with the technological advances that have taken place in the intervening three years. The actual reference platform (VAX 11/780) is no longer a valid reference machine.

Because of these issues, the benchmark has been redesigned and is now available as SPEC95. The standard reference machine is a SparcStation 10/40 with a 40 MHZ SuperSparc processor. The newer SPEC95 benchmarks are more comprehensive and must be run a minimum of three times. The three runs are then averaged to insure that a normalized rating is achieved.

As with SPEC92, the SPEC95 CPU benchmarks consist of two suites, an integer suite and a floating point suite. They are component level benchmarks because they are designed to test the CPU, caches, memory, and the compiler. They are specifically designed to make the effects of I/O, network, display, and operating system performance negligible on the benchmark results.

The major drawback to the new SPEC benchmark is that its rating cannot be directly compared to the results of the previous benchmark (SPEC92). There was a conscious decision not to provide a conversion scale between SPEC92 and SPEC95. This was done to insure that SPEC results would not be confused. A SPEC92 benchmark result is reflected as a four-digit number with one decimal place (i.e., 100.4) while a SPEC95 benchmark result will be a three-digit number with two decimal places (i.e., 2.56). The following table provides a comparison of SPEC92 and SPEC95 results.

SYSTEM	SPEC92 (SPECint92)	SPEC95(SPECint95)
Pentium® Processor 75 MHZ	N/A	N/A
Pentium® Processor 90 MHZ	N/A	N/A
Pentium® Processor 100 MHZ	137.7	3.33
Pentium® Processor 120 MHZ	157.3	3.77
Pentium® Processor 133 MHZ	174.2	4.20
Pentium® Processor 150 MHZ	181.4	4.35
Pentium® Processor 166 MHZ	197.5	4.82

Source: *Intel WWW Homepage 5/7/97, http://pentium.intel.com*

A.5 CPUmark32/WinBench 96

The CPUmark32 test suite is part of a larger benchmark called WinBench 96. CPUmark32 is a 32-bit test suite that gauges processor behavior when running 32-bit applications. If a system is going to be running a solid mix of 16 and 32-bit applications, then the CPUmark16 can be used to give comparative performance for 16-bit applications.

The following table gives representative samples of CPUmark16 and CPUmark32 results for systems running Windows 95. As always, higher numbers represent better performance.

PROCESSOR	CPUmark16	CPUmark32
486DX2/66	83	92
Pentium® 75 MHZ	169	171
Pentium® 90 MHZ	203	204
Pentium® 100 MHZ	225	228
Pentium® 120 MHZ	253	243
Pentium® 133 MHZ	281	301
Pentium® 150 MHZ	309	311
Pentium® 166 MHZ	334	343

Source: *Intel WWW Homepage 5/7/97, http://pentium.intel.com...mainstream/CPUmark32.html*

The WinBench 96 Benchmark suite is the newest version of the Ziff-Davis industry-standard PC benchmarks. WinBench provides detailed information indicating how a PC's major subsystems--processor/RAM, graphics disk, CD-ROM, and full-motion video perform under Windows 3.x or Windows 95. One of the best features of the Ziff-Davis benchmarks is that they can be obtained free of charge from Ziff-Davis. A copy of WinBench 96 is available from the Ziff-Davis Benchmark Operation (ZDBOp) homepage on the World Wide Web (http:www.zdnet.com/). This version does not contain the new CD-ROM or video performance tests. These tests and the associated files they require are too large for downloading. Information is available on the Web page on how to obtain the additional tests on CD-ROM.

A.6 iCOMP® INDEX

Intel created the Intel COmparative Microprocessor Performance (iCOMP) index to provide a simple, relative measure of Intel processor performance. It is not a true benchmark but uses current industry standard benchmarks (weighted) to arrive at a relative number. It measures four aspects of both 16 and 32-bit processor performance: integer operations, floating-point operations, graphics, and video performance. The weights of the particular benchmarks are based on the estimated percentage of time the processor spends doing the particular operations measured by the benchmark.

These weights are used in the following formula:

iCOMP® Index = 100 * (PCBench 7.0 Processor Harmonic/6792.91)**0.68 * (Whetstone/150.2)**0.02 * (SPECint92/14.24)**0.25 * (SPECfp92/0.45)**0.05

The benchmark weights are represented in the following figure:

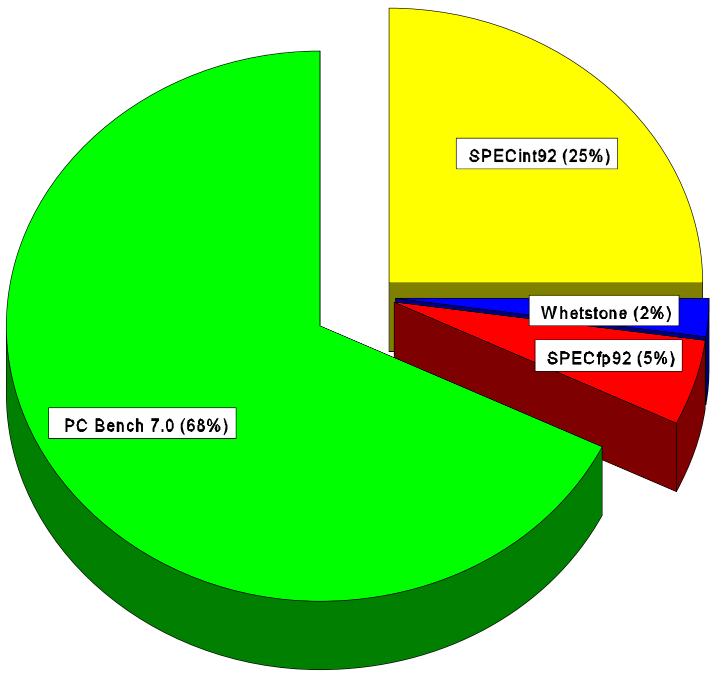


Figure A-2.

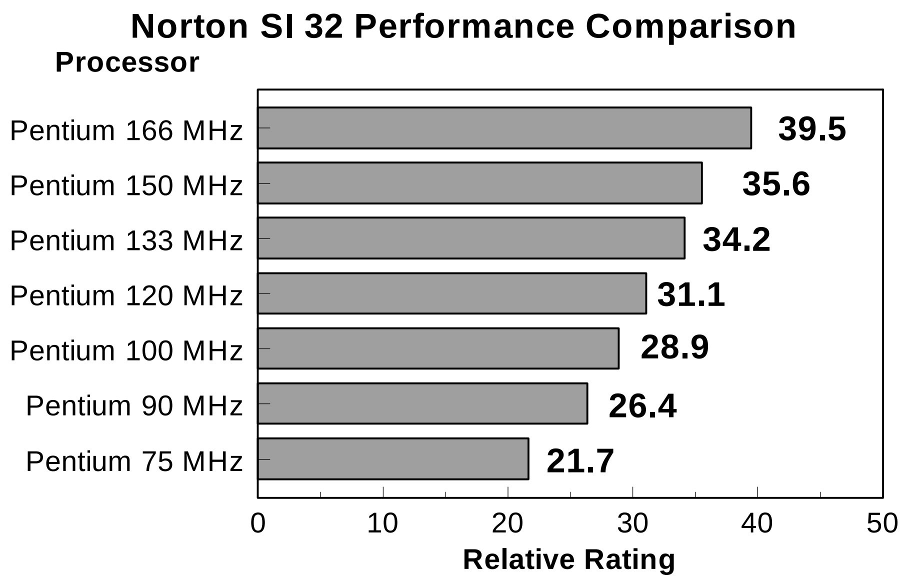
A-7 OTHER BENCHMARKS

In addition to the use of the required benchmarks, there are several other benchmarks that provide additional validation of system performance.

Norton SI 32

This benchmark is a relatively new benchmark for Windows 95. It is designed to show the speed of a computer subsystem (CPU, L2, and memory) for running common 32-bit applications. This benchmark is part of the SYSINFO module of the Norton Utilities for Windows 95.

The following chart shows comparative Norton SI 32 benchmarks for Intel processors.



Winstone 96

Winstone 96 is the current upgrade to the Winstone benchmark. It is significant because it provides applications-based benchmarking. It uses scripts that execute real Windows applications to produce an overall measure of a PC's performance under Windows 3.x or Windows 95. The scripts execute 13 different applications including Lotus 1-2-3, Microsoft Word 6.0, CorelDraw, and dBase 5.0 for Windows. Because most of the applications in use today are 16-bit, Winstone 96 uses 16-bit Windows applications. As more 32-bit applications become available for Windows 95, it is anticipated that the Winstone benchmark will be upgraded to use 32-bit applications in the benchmark suite. As noted in section A.1, 16-bit and 32-bit applications differ significantly in how they use the processor and its resources.

The Winstone benchmark should be considered another tool to use to measure performance, particularly if your primary applications will be windows based.

Processor Performance Rating (P-rating)

This rating was recently introduced by a coalition of companies (AMD, Cyrix, IBM Microelectronics, and SGS-Thompson) as a method for comparing all processors on the market against a reference platform based on a Pentium® processor. The main goal was to provide a single, application-based performance number that an end user could easily understand, instead of using frequency (MHZ) and processor architecture.

The rating is based on running the Winstone 96 benchmark on the reference platform and on the benchmark platform and obtaining comparative values. This process is repeated using Pentium® processors of different frequencies in order to provide a range of comparative values. When the Winstone value for the benchmark system is compared to the Winstone values for the different Pentium® processors, the benchmark system will get the rating of the Pentium® system that is closest to its Winstone value. For example, if the benchmark system scored a 54.0 on the Winstone and the two closest Pentium® Winstones were 52.1 (90 MHZ) and 55.0 (100 MHZ), the benchmark system would be given a P rating of P100.

This system is not widely used at the current time, but it has merit since the current practice for vendors is to compare their system's performance against the performance of a Pentium® system.

APPENDIX B

EPA ENERGY STAR PROGRAM

B.1 BACKGROUND

In 1993, President Clinton signed Executive Order 12845 directing U.S. agencies to purchase only desktop computers, monitors, and printers that meet the Environmental Protection Agency's Energy Star requirements for energy efficiency. The only criteria assigned to this order are that the systems must be commercially available and meet the agencies' performance needs. This Executive Order took effect on October 1, 1993.

B.2 APPLICABILITY

In compliance with the Executive Order, DOD has determined that all COTS PCs procured by DOD must comply with the order. There has not been a determination of whether this applies to tactical computers or just the administrative/general use computers procured by DOD.

B.3 PURPOSE

The purpose of this order is to encourage environmentally sound programs and to cut costs. The use of Energy Star compliant equipment should save more than $40 million annually. In addition, with the exception of nuclear power plants, the generation of electricity contributes significantly to air pollution. Electrical generation accounts for more than 35 percent of all U.S. emissions of carbon dioxide. It also accounts for more than 75 percent of sulfur dioxide emissions and 38 percent of all nitrogen oxide emissions.

Computers are the fastest growing electricity loads in the business world. They currently account for more than 5 percent of commercial electricity consumption. Any conservation efforts will have a direct and immediate effect on electrical consumption and ultimately, air pollution.

To qualify for the Energy Star logo, the equipment must consume 30 watts or less when idle. The consumption of electricity during idle times is a significant issue of the Energy Star program.

B.4 IMPLEMENTATION

As noted, the Executive Order applies to all desktop computers, monitors, and printers. While the Energy Star strategy is very generic and can be easily applied to current systems, the implementation will vary between the pieces of equipment.

Energy conservation techniques have come about in desktop computers without the need for specific guidance or programs. This is because the desktop environment is adopting energy efficient components from the portable computer arena where energy conservation has been paramount due to the reliance on batteries for power and the requirement to reduce heat buildup. It is intuitively obvious that to increase battery life, a system should not allow devices to consume large amounts of energy when in an "idle" mode. The BIOS of portable computers has been redesigned to monitor the activity of different devices (e.g., hard drives, monitors) and to reduce energy consumption when the devices are idle. This is done by several methods, but the most effective method is to use screen savers when the monitor is sitting "idle" and to let hard drives spin down when they sit idle for a specific period of time.

In addition, the power consumption of the CPU has been reduced through voltage reduction technology so that the CPU will consume less power and will reduce heat buildup. CPU chips have reduced normal power ratings from above 5 volts to as little as 3.3v. The voltage reduction technology is being implemented across computer systems to include desktop systems.

One of the most significant implementations of the Energy Star criteria has been in the area of monitors/displays. A typical PC monitor draws about 50 watts and, if left on 24 hours a day, consumes about $35 of electricity a year. New hardware and software improvements are responsible for meeting the Energy Star requirements. Windows 95 has built-in Energy Star features that can be enabled. The screen saver module allows the user the option of allowing the monitor to go to a low power standby after particular periods of inactivity.

In order to comply with the Energy Star requirements, most monitor and printer manufacturers have built in sleep modes that reduce power consumption after a set period of inactivity. This will obviate the need for any special configuration of the operating system to take place.

All computers procured for DOD must meet the Energy Star requirements and receive official "branding." A list of equipment that has received the EPA's Energy Star certification can be found on the World Wide Web at http:/www.epa.gov/energy--star.

APPENDIX C

FORTEZZA

C.1 BACKGROUND

Fortezza is the name given to the program designed to implement desktop level security for the electronic exchange of data. It is a key security component of the Defense Message System and the Multilevel Information Systems Security Initiative (MISSI). Fortezza is actually a PCMCIA Cryptographic Card that will be used in conjunction with COTS computers and workstations for the transmission of sensitive information over unclassified, nonsecure networks.

C.2 FUNCTIONALITY

The Fortezza card is a crypto device capable of supporting security aware applications. It is envisioned that the Fortezza cards will be used in the following applications:

- Encrypted CD-ROM Distribution.
- File encryption and decryption.
- Authentication of users and network services.
- Defense Message System (DMS).
- Secure Electronic Mail.
- Electronic signatures and data integrity checks.

As noted, the primary requirement for PCMCIA card capability in the minimum configuration is to support implementation of DMS.

C.3 TECHNICAL SPECIFICATIONS

Fortezza is actually a PCMCIA, Type II compliant cryptographic card. The card contains a low-power, 32-bit, reduced-instruction-set computing processor. It has a 68-pin edge connector and complies with Card and Socket Services Version 2.1, a standard of the Personal Computer Memory Card International Association.

The following table summarizes the key technical specifications:

Fortezza Crypto Card-Technical Specifications	
Feature	**Specification**
Configuration	PCMCIA (v2.1) Type II card
Size	85.6 mm (l) x 54.0 mm (w) x 5.0 mm (t)
Processor	Capstone chip (10 or 20 MHZ)
Volatile storage	128K Static RAM
Non-Volatile	128k or 512K EEPROM
Power	5v
Battery	Lithium battery with 7 year lifespan
Clock	On board Real-Time Clock
Encryption	SKIPJACK
Digital Signature	NIST DSA (FIPS PUB 186)

Further information can be obtained by calling the National Security Agency at 800-GO-MISSI (800-466-4774).

APPENDIX D

ACRONYMS

ATA	Advanced Technology Attachment
BIOS	Basic Input/Output System
CAD	Computer Aided Design
COE	Common Operating Environment
COTS	Commercial Off-the-Shelf
CPU	Central Processing Unit
DII	Defense Information Infrastructure
DISA	Defense Information Systems Agency
DMS	Defense Message System
DRAM	Dynamic Random Access Memory
EC/EDI	Electronic Commerce/Electronic Data Interchange
ECP	Extended Capability Port
EDO	Extended Data Out
E-IDE	Enhanced Intelligent Drive Electronics
EPP	Enhanced Parallel Port
EPROM	Erasable Programmable Read-Only Memory
EEPROM	Erasable Electrically Programmable Read-Only Memory
FDDI	Fiber Distributed Data Interface
GCCS	Global Command and Control System
GCSS	Global Combat Support System
I/O	Input/Output
IDE	Integrated Drive Electronics
ISA	Industry Standard Architecture
ISO	International Standards Organization

JTA	Joint Technical Architecture
MISSI	Multilevel Information Systems Security Initiative
PCI	Peripheral Component Interconnect
PCMCIA	Personal Computer Memory Card International Association
PCs	Personal Computers
PnP	Plug and Play
POSIT	Profile of Open Systems Internetworking Technology
POSIX	Portable Operating System Interface
RAM	Random Access Memory
SCSI	Small Computer Systems Interface
SDRAM	Synchronous Dynamic Random Access Memory
SIPRNET	Secret Internet Protocol Router Network
SRAM	Static Random Access Memory
SVGA	Super Video Graphics Adapter
TAFIM	Technical Architecture Framework for Information Management
TCP/IP	Transfer Control Protocol/Internet Protocol
UART	Universal Asynchronous Receiver/Transmitter
VESA	Video Electronics Standards Association
VRAM	Video Random Access Memory
WWMCCS	WorldWide Military Command and Control System